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USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 92

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USSR REPORT

MATERIALS SCIENCE AND METALLURGY

No. 92

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ALUMINUM AND ITS ALLOYS

UDC 620.178.38:539.43

CYCLICAL FRACTURE TOUGHNESS OF ALUMINUM ALLOY K_{Ifs}

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 19, No 3, May-Jun 83 (manuscript received 11 Jan 82) pp 43-46

KUDRYASHOV, V. G.

[Abstract] The hypothesis of Irwin that fracture occurs when the stress intensity factor reaches the critical value K_{Ic} was confirmed in evaluating the strength of various structures of quasi-brittle materials operating under long-term static loading or smoothly and rather slowly changing loading. It can be assumed that in fatigue fracture, failure occurs when the maximum stress intensity factor of the cycle at the tip of the fatigue crack reaches the critical value K_{Ifc}. The greatest difference of K_{Ifc} from K_{Ic} is observed where R=0, when practically the entire plastic zone before fracture is a cyclic plastic zone determined by the value of ΔK. With an intermediate cycle asymmetry factor, the plastic zone is formed under the influence of constantly increasing mean stress intensity factor of the cycle K_m and simultaneously increasing ΔK. Figures 1; references 5: 4 Russian, 1 Western. [156-6508]

UDC 669.71:669-131

HIGH STRENGTH MALLEABLE ALUMINUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7, Jul 83 pp 13-16

TKACHENKO, Ye. A., FILIPPOVA, Z. G. and KHOL'NOVA, V. I.

[Abstract] The production of stronger alloys than D16 duralumin type Al-Cu-Mg alloys required the study of new systems with greater solid solution areas in which the solubility of the elements introduced to the aluminum changes with a decrease in temperature. New high strength alloys with better mechanical properties have been obtained by using Al-Zn-Mg-Cu systems. A number of such alloys are described, including V95 (developed in 1948), V96TS (1956), V96TS-1 (1968), V96TS-3 (1970), V93 (1957), V95pch (1971), V95och (1971) and V93pch (1971). The chemical compositions of these alloys are presented in tabular form. Their corrosion resistance, influence of copper content on mechanical properties of aluminum alloys and influence of magnesium content on ductility are traced. Figures 3; references 8: 7 Russian, 1 Western. [157-6508]

UDC: 669.71:669.131

HEAT RESISTANT MALLEABLE ALUMINUM ALLOYS, PROSPECTS FOR THEIR DEVELOPMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 7, Jul 83 pp 9-12

ROMANOVA, O. A.

[Abstract] The development and broad utilization of heat resistant malleable aluminum alloys has facilitated the development of jet engines. Alloys AK4 and AK4-1, based on aluminum, copper, magnesium, iron and nickel, plus silicon in AK4-1, with a total alloy content of not over 4-4.5% including 0.8 to 1.5% each of iron and nickel are different in structure from duralumin-type alloys. VD17 alloy, which can operate at over 200°C, is a duralumin type Al-Cu-Mg-Mn alloy with significantly greater long-term strength and creep resistance than AK4 and AK4-1. Its chemical composition is 2.6-3.0% Cu, 2.0-2.4% Mg, 0.45-0.7% Mn, and not over 0.3% each Fe and Si. D20 and D21 alloys are also described, the latter being superior to AK4-1 in long-term strength and creep resistance. Of the rare earth metals, germanium has the most positive influence on the structure and properties of D21 alloy, increasing strength at both room temperature and elevated temperatures when present at 0.1-0.2%. Decreasing the content of iron and nickel in these alloys can improve fracture toughness. Significant studies have been performed in the area of heat resistant malleable aluminum alloys, both in terms of improvement of series produced alloys and development of new alloys with good strength properties, heat resistance and satisfactory ductility. Figures 4; references 9: 8 Russian, 1 Western. [157-6508]

UDC 669.71:620.17:620.186

SPECIFICS OF STRUCTURE AND PROPERTIES OF 1420 ALUMINUM ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7, Jul 83 pp 20-22

FRIDLYANDER, I. N., SANDLER, V. S. and NIKOL'SKAYA, T. I.

[Abstract] Over the past 20 years alloys have been developed containing lithium. VAD23 Al-Cu-Li-Cd alloy contains 1.2% Li, and type 1420 contains 2% Li plus 5.5% Mg, 0.15% Zr, remainder Al. The optical composition of this alloy was established by systematic study of Al-Mg-Li alloys, revealing the effect of aging in alloys over a broad range of magnesium and lithium concentrations. Microdiffraction analysis established that in contrast to sheets, pressed semifinished goods usually have fine grained recrystallization structure with a near equiaxial grain about 20 μm in size and a small quantity of subgrains. Debye diagrams obtained in reflection with specimens from the heart of sheets and pressed semifinished goods show arcs and individual reflexes of extended form. Sheets, in contrast to pressed semifinished goods, show clear textural

maxima. This characteristic can apparently be used for radiographic differentiation of fine grain recrystallization and primarily nonrecrystallized structure of type 1420 alloy specimens. Figures 3; references 6: all Russian. [157-6508]

UDC 669.71:620.17:620.18

INFLUENCE OF RICH COOLING RATES IN CRYSTALLIZATION ON STRUCTURE AND PROPERTIES OF Al-Mg-Li SYSTEM ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7, Jul 83 pp 22-23

STEPANOVA, M. G., VALYAYEVA, V. I., GERCHIKOVA, N. S. and PARKHOMENKO, N. A.

[Abstract] Results are presented from a comparative study of the structure and properties of pressed strips of Al-Mg-Li alloy manufactured from dispersed particles produced by various methods of rapid cooling during crystallization: spraying of the melt under pressure, spraying through perforated plates in a centrifugal granulator and cooling on a copper substrate, producing powder, granules and film, respectively. Cooling at high rates produce a homogeneous highly dispersed dendritic structure in these alloys. The presence of a supersaturated solid solution in the initial material, be it powders, granules, or fibers leads to more rapid decomposition of the solid solution with liberation of an ordered δ' phase (Al_3Li) during heat treatment. Figures 2; references 4: 3 Russian, 1 Western.
[157-6508]

UDC 669.71:620.186.5

INFLUENCE OF INITIAL SEMIFINISHED GOOD STRUCTURE ON 'CRITICAL' RECRYSTALLIZATION OF AK4-1 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7, Jul 83 pp 26-28

BOBOVNIKOV, V. N.

[Abstract] For most metals including aluminum alloys, "critical" recrystallization is a characteristic process, accompanied by rapid grain growth as a result of the joint effects of cold deformation and subsequent heating. The greatest difficulty is created by deformation with small critical degrees, which cannot be avoided in part shape alteration. A decrease in the most important characteristics of the alloy requires the search for a method of preventing critical recrystallization. Grain growth as a result of critical recrystallization is determined to a great extent by the initial structure of the material. In the stable stage of hot pressure working, the formation of

structure is determined by the temperature-speed conditions of deformation. Considering all this, the formation of the structure of AK4-1 alloy during pressing and annealing was studied using industrial batches of shapes with web thickness 2-10 mm, degree of deformation 87 to 95%. Pressed ingots were homogenized by the standard methods for the alloy at 350, 370, 380 and 400°C. The structure of profiles in the hot pressed state and after annealing at 300, 350 and 400°C were determined by the x-ray structural method and the K_α radiation method. The radiograms showed that AK4-1 is subject to dynamic recrystallization beginning at a temperature inversely proportional to the deformation rate. A technological process was developed for production of hot pressed and annealed profiles assuring good technological properties of semifinished goods and allowing elimination of the formation of large crystal structures in the manufacture of parts. Figures 4; references 5: 4 Russian, 1 Western.
[157-6508]

UDC 620.172.251:669.71'1'721'3'24

MECHANICAL PROPERTIES OF AK4-1 ALLOY AT HIGH TEMPERATURES

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7 Jul 83 pp 34-38

BICH, E. N. and TELESHOV, V. V.

[Abstract] A study is made of the influence of content of the major alloying elements in type AK4-1 alloy, including copper, magnesium, iron and nickel, on its mechanical properties at elevated temperatures. The microstructure of pressed strips is illustrated and curves of long-term strength and ductility at 135°C and creep over 100 hours at 175°C and σ=216 MPa are illustrated. The mechanical properties are determined as a function of volumetric content of intermetallides in the alloy. In short-term static extension, regardless of test temperature between 20 and 175°C, increasing the content of copper, magnesium, iron and nickel to the maximum increases strength properties for smooth specimens and decreases strength properties of notched specimens. Under long-term static extension, an increase in the content of iron and nickel to moderate values leads to an increase in long-term strength at 135-175°C, a decrease in strength if the content of these elements reaches the upper of the type (1.4%). The greatest long-term strength is that of pressed strips with moderate contents of the main alloying elements. Notch sensitivity under short-term and long-term static loading depends on the content of iron and nickel, which determines the quantitle of intermetallic $FeNiAl_9$. Notch sensitivity varies directly with iron and nickel content.
Figures 3; references 7: 6 Russian, 1 Western.
[157-6508]

UDC 669.71:"313"

SOME MEANS FOR IMPROVING DURALUMINS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 7, Jul 83 pp 38-43

DRITS, A. M., SILAYEV, P. N., deceased, VOVNYANKO, A. G. and
ZAYKOVSKIY, V. B.

[Abstract] Al-Cu-Mg alloys (duralumins) are widely used in aviation and space technology, usually after hardening, deformation by extension and natural aging (T state). Among the trends in improving the combination of properties of duralumins, the two most important are improvement of the technology of manufacture of semifinished goods and optimization of the chemical composition of alloys. The influence of iron and silicon impurities is analyzed as is the influence of the major alloying elements. Studies have resulted in a maximum limitation of copper content to 4.4% or less. This article presents the results of studies of a combination of properties of large numbers of batches of pressed semifinished goods including strips, panels and profiles of the alloy utilizing all known principles for optimization of the composition. The studies show that significant improvements in characteristics determining the operating life and reliability of products made of pressed Al-Cu-Mg alloys can be achieved by simultaneous application of three principles: decreasing the content of iron and silicons; decreasing the content of copper and manganese; and additional alloying with zirconium. Figures 2; references 21: 17 Russian, 4 Western.
[157-6508]

UDC 669-1-126:669.71'721'793

HOMOGENIZATION OF Al-Mg-Sc SYSTEM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7,
Jul 83 pp 60-63

DRITS, M. Ye., TOROPOVA, L. S. and BYKOV, Yu. G.

[Abstract] A study was made of the influence of various homogenization conditions on the structure and properties of Al-Mg-Sc alloys. Studies were performed on hot pressed semifinished goods with scandium introduced in high magnesium alloys: Al-4.40%, Mg-0.25% Sc; Al-6.31% Mg-0.21% Sc; Al-8.28% Mg-0.30% Sc. Ingots were annealed at 400, 450 and 500°C for 2 to 100 hours. Electron microscope studies were performed, establishing that in the Al-6.31% Mg-0.21% Sc in all studied states there were secondary uniformly distributed spherical forms of $ScAl_3$ phase particles. A decrease in homogenization annealing temperature and decrease in holding time was found to increase the yield point of Al-Mg-Sc alloys. The optimal homogenization condition was heating to 400°C, holding time 10 hours. This produced small

coherent segregations of $ScAl_3$ and dissolved the excess β phase segregations. $ScAl_3$ phase particle growth kinetics were studied and full coherence found with the matrix of $ScAl_3$ particles up to 1160 A in diameter. Figures 2; references 8: 6 Russian, 2 Western.
[157-6508]

UDC 669.793'71:620.186

SOME SPECIFICS OF DECOMPOSITION OF SOLID SCANDIUM SOLUTION IN ALUMINUM

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 7, Jul 83 pp 57-60

YELAGIN, V. I., ZAKHAROV, V. V. and ROSTOVA, T. D.

[Abstract] A study is made of the specifics of decomposition of scandium solid solutions in aluminum in ingots of Al-0.41% Sc to provide an approximate estimate of the temperature-time parameters of homogenization and pressure working of aluminum alloys containing scandium. Continuous casting was used to produce ingots 134 mm in diameter containing 0.01% Fe and 0.01% Si in addition to Al and Sc as above. Scandium was primarily found in a supersaturated aluminum solution upon cooling of the ingots to the solidus temperature. The results produced, characterizing the kinetics of decomposition of the supersaturated scandium solid solution, indicate very low stability of the solid solution. It can be recommended that when aluminum alloys containing scandium are heated for homogenization and pressure working, the temperature should be maintained at the minimum possible level with the minimum holding time in order to prevent or minimize coagulation of the products of decomposition of the scandium solid solution in aluminum. Hot pressure working should be performed without homogenization at 300-350°C. Figures 4; references 5: all Russian.
[157-6508]

UDC 669.71'295:620.186.2

SPECIFICS OF DENDRITIC LIQUATION OF TITANIUM IN ALUMINUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 7, Jul 83 pp 55-57

SETYUKOV, O. A., FRIDLYANDER, I. N. and RUCH'YEVA, N. V.

[Abstract] The method of local x-ray spectral analysis is used to determine the concentration of titanium at the center and periphery of dendritic solid solution cells of aluminum and in excess intermetallides of cast and high temperature annealed alloys based on aluminum containing magnesium, copper and zinc individually and in combination, and also in ingots of the industrial

alloys AMg6, D1, V95 and AL19 containing 0.03 to 03% Ti. The modifying effect of titanium on grain size in aluminum alloy ingots was found to follow two directions: formation of zones in the liquid phase near the liquidus which are rich in titanium and phase particles containing titanium. Microscopic x-ray spectral analysis establishes that the concentration of titanium in various solid solution cells may differ greatly. It is quite high far from the boundary, and practically zero on boundaries, subgrains, in peripheral zones and at the center of individual cells. The presence of titanium in complexly alloyed specimens may accelerate decomposition of the aluminum solid solution during heat treatment. The maximum solubility of titanium in aluminum alloys may be as great as 1.3% even with very low cooling rates during solidification. Figures 4; references 6: all Russian.
[157-6508]

UDC 621.762:669.018.45

CONDUCTIVITY OF CONSOLIDATED POWDER COMPOSITE MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 83
(manuscript received 20 May 82) pp 73-76

GORINSKIY, S. G., GAVRILOV, F. F. and BEKETOV, A. R., Urals Polytechnical Institute imeni S. M. Kirov

[Abstract] A study is made of the structure of composite materials in which the effect of decreasing conductivity during the process of consolidation is observed. A model system of densely compacted circles is analyzed at the nodes of a triangular lattice. It is assumed that in the process of material transfer the nonconducting component may find itself in the area of a neck between two conducting particles, thus "breaking" conductivity. The concept of the vicinity of connection between two particles of conducting phase is made more specific by studying three cases: 1) mean length of transfer of nonconducting phase significantly greater than distance between neighboring grains; 2) mean length approximately equal to distance between neighboring grains; 3) mean length of transfer significantly less than distance between neighboring grains. The length of transfer of the nonconducting phase in a TiC-SiC composite is found to be significantly greater than the length of transfer of polystyrene in the process of viscous volumetric flow, indicating that the main mechanism of mass transfer in porous composites containing silicon carbide is diffusion through the gas phase. An equation is derived which relates connectedness to nonconducting component transport distance. Figures 3; references 10: 5 Russian, 5 Western.
[153-6508]

UDC 539.4:677.494

ANALYSIS OF MODELS FOR CALCULATION OF ACHIEVEMENT OF STRENGTH BY ARAMIDE FIBERS IN THREADS AND MICROPLASTICS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 83 (manuscript received 9 Nov 92) pp 387-390

KOMPANIYETS, L. V., POTAPOV, V. V., GRIGORYAN, G. A., KUPERMAN, A. M., PUCHKOV, L. V. ZELENSKIY, E. S., BERLIN, Al. Al., PRUT, E. V., and YENIKOLOPYAN, N. S., Institute of Chemical Physics, USSR Academy of Sciences, Moscow

[Abstract] Based on the statistical theory of strength, models are studied for calculation of the achievement of strength characteristics of aramide fibers in untwisted thread and microplastics. Threads and microplastics were tested either in paper frames or without them. The σ-ε deformation diagrams of threads and microplastics were obtained on an Instron-1122 test machine. Modulus of elasticity was determined from the initial slope of the diagrams. It was found that the diagram is initially linear, the slope tangent decreasing slightly before failure. It was found that the strength of microplastics can be determined based on the model of accumulation of damage. The degree of achievement of the potential strength of fibers in the microplastics is virtually independnet of the initial level of aramide monofilament strength of the nature of the epoxy binders used for a given variational coefficient of monofilament strength. Figures 2; references 11: 9 Russian, 2 Western.
[158-6508]

UDC 620.1:678

INFLUENCE OF PROTON-ELECTRON BOMBARDMENT ON PROPERTIES OF DISPERSELY REINFORCED COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 83 (manuscript received 10 Dec 82) pp 552-554

KONONENKO, V. G., deceased, MARKUS, A. M., KOBRIN, V. N., VELICHKO, N. I., and UDOVENKO, V. F., Khar'kov Aviation Institute imeni N. Ye. Zhukovskiy; Physico-Technical Institute of Low Temperatures, Ukrainian Academy of Sciences, Khar'kov

[Abstract] A study was made of the resistance of dispersely reinforced materials to the effects of proton and electron bombardment under deep vacuum conditions. The objects of the study were composite specimens of two compositions containing heat treated finely ground basalt as the filler, epoxy-organosilicon resin DFM-135 plus L-20 curing agent or sodium silicate plus 2% sodium fluosilicate as the binder. The specimens were cubes with rib length 0.01 m. Studies were performed in a high vacuum cryogenic chamber with the specimens in a special holder. An ionic HF source and electron gun supplied the corpuscular radiation. An electrostatic scanning system allowed

the specimens to be irradiated over areas of up to 100 cm^2. Specimens were bombarded by electrons and proton beams at doses of 10^{14}-10^{16} particles per square centimeter. Visual examination showed darkening of the specimens, increasing with increasing radiation. The darkening is an oxidative process in the binder. Study of the microstructure of the epoxy-organosilicon binder revealed a boundary between the proton-bombarded and nonbombarded zones. Significant changes in mechanical properties were observed, resulting from the formation of microfissures on the irradiated surface, which developed into macrofissures upon deformation. Figures 4; references 4: all Western.
[158-6508]

UDC 620.178:678

EXPERIMENTAL STUDY OF THERMAL CYCLING LOADING OF DISPERSELY REINFORCED COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 83 (manuscript received 10 Nov 82) pp 457-459

UDOVENKO, V. F., KOBRIN, V. N., YEL'CHANINOV, V. P., GRECHKA, V. D. and KUSHNARENKO, S. G., Khar'kov Aviation Institute imeni N. Ye. Zhukovskiy; Physico-Technical Institute of Low Temperatures, Ukrainian Academy of Sciences, Khar'kov

[Abstract] A study is presented of the influence of thermal cycling on the strength properties of composite specimens of three compositions in the 140-135°C area for 60 cycles under deep vacuum conditions. The specimens were cubic in shape, rib length 0.01 m. The filler in the specimens was heat treated finely ground basalt, the binder was epoxyorganosilicon resin type DMF-135 plus a curing agent; sodium silicate plus 2% sodium fluosilicate; orthophosphoric acid (specimens a, b and c). The macrostructural studies showed that after thermal cycling in a deep vacuum the binder substances were sublimated from the surface of the specimens, revealing the mineral particles. Compressive strength testing revealed that deep vacuum decreases compressive strength of epoxy-organosilicon binder specimens by 0.97%, thermal cycling additionally decreases it by 7.18%. The greatest influence on strength property loss in the "a" specimens is that of the cyclical temperature drop, for specimens "b" the most important weakening factor is vacuum. The compressive strength of specimens "c" drops slightly both as a result of vacuum (by 0.45%) and as a result of vacuum plus thermal cycling (by 1.21%). Figures 3; references 5: all Russian.
[158-6508]

UDC 539.3:677.4

INELASTIC DEFORMATION OF CERTAIN HIGH MODULUS REINFORCING FIBERS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 83
(manuscript received 25 Oct 82) pp 391-394

ZOSIN, L. P., VERKHOVETS, A. P., KUZ'MIN, V. N., LEVIT, M. R., LELINKOV, O. S. and PEREPELKIN, K. Ye., Leningrad Branch, All Union Scientific Research and Planning Institute of Artificial Fiber

[Abstract] High-strength composite materials are increasingly reinforced with superstrong and superhigh modulus organic fibers based on parapolyamides such as Kevlar. These fibers have amorphous-crystalline structure with three-dimensional ordering of crystalline areas. In spite of the great rigidity of the molecular chains and strong intermolecular interaction, the fibers are characterized by forced elastic deformation, limited slip and slow relaxation even at room temperature. Kevlar yields a clear high angle reflex diffractogram of several orders in the meridional, equatorial and diagonal planes, allowing the elastic properties of crystallites to be studied easily. The phenomenon of inelastic deformation under cyclical loading was studied by mechanical hysteresis using a universal instron-1195 test machine. The deformation rate was 10 mm/min for specimens with a base of 100 mm. Acoustical measurements of dynamic elasticity modulus were performed at 50 KHz. The molecular mechanism of deformation was studied by an x-ray diffraction method. The studies showed that in superhigh modulus organic fibers inelastic deformation phenomena accompanied by notable hysteresis are characteristic, obviously related to the inhibition of conformation transitions. This phenomenon is based on the significant potential barriers of rotation and strong intermolecular interaction allowing only cooperative conformation transitions in response to mechanical stress near the fracture stress. Figures 5; references 16: 12 Russian, 4 Western.
[158-6508]

ENERGY EFFECTS

MELT FLOW UPON LASER EVAPORATION OF METAL FILMS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 3, May-Jun 83 (manuscript received 14 Jun 82) pp 18-21

VEYKO, V. P., KAYDANOV, A. I., TUCHKOVA, Ye. A. and YAKOVLEV, Ye. B., Leningrad

[Abstract] A theoretical analysis is made of the process of unsteady flow of a melted film away from the zone of laser evaporation. The boundary conditions must consider the influence of film adhesion on the melt flow rate. Numerical solution of the equation system derived jointly with equations for film and substrate heating was undertaken for a film of aluminum $2 \cdot 10^{-7}$ m thick on a substrate of fused quartz, heated by a $2 \cdot 10^{-8}$ s laser pulse with a radiation flux density at the film surface of $2 \cdot 10^{12}$ W/m^2. It was found that the fraction of liquid phase in the products depends strongly on the dimensions of the irradiated area, increasing as dimensions decrease. The ratio of liquid to vapor phase also depends greatly on the incident light flux density, liquid phase decreasing with an increase in flux density. When the flux density is significantly over a certain threshold value, the mechanism of destruction can be considered purely evaporative. Figures 2; references 7: 4 Russian, 3 Western.
[154-6508]

04EP-10M PRECISION HIGH-FREQUENCY ELECTRIC EROSION SMALL-DIAMETER DRILLING MACHINE

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 3, May-Jun 83 (manuscript received 15 Aug 82) pp 76-78

BOYKO, A. F., BRATIVNIK, Yu. M. and KHUKALENKO, Yu. A., Belgorod

[Abstract] A description is presented of the 04EP-10M small-diameter electric erosion drilling machine. Technical characteristics of the machine are presented. It has a 140 x 140 mm stage with movement range 20 x 20 mm, can drill apertures 0.015-0.5 mm in diameter to a maximum depth of 20

electrode diameters, accuracy of aperture placement ±0.002 mm, linear drilling speed for 0.015-0.1 mm apertures 0.5-1.5 mm/min, roughness of surface 0.1-0.4 μm, power consumption 0.25 kW, and mass 160 kg. An experimental group of machines was manufactured and introduced in production in 1981. The annual economic effect of introduction of five machines was 170,000 rubles. Series production was begun in 1982. Figures 1; references 15: 11 Russian, 4 Western.
[154-6508]

PROBLEM OF MAXIMUM DESTRUCTION RADIUS UPON ELECTRIC BREAKDOWN OF SOLIDS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 3, May-Jun 83 (manuscript received 9 Oct 81) pp 54-57

ALEKSEYEVA, T. I., KURETS, V. I. and FILATOV, G. P., Tomsk

[Abstract] An attempt is made to calculate the maximum crack length formed upon electric pulse breakdown of solids based on a model described in a previous work. The calculations are based on the following system of assumptions: the energy liberated in the discharge channel in a period less than 1/4 the period of oscillation of the discharge current is expended in expansion of the channel, formation of the primary fracture zone and equiprobable generation of a certain number of cracks from the boundary of the first zone in all directions; the energy expended in the discharge channel subsequently as long as quasi-constant resistance of the discharge channel is maintained determines the length of the major cracks and is converted to deformation energy of the volume. The results of experiments and determination of the maximum radius of fracture of materials under these conditions are presented in a table. They indicate that the equations suggested can be used to determine the maximum crack length formed upon breakdown of the material studied. Agreement of calculated values with actual results for rocks and ores will be determined by the accuracy of selection of strength and elasticity characteristics of the material for calculation. Figures 1; references 8: all Russian.
[154-6508]

COMBINED UTILIZATION OF MINERAL RESOURCES

Moscow PLANOVOYE KHOZYAYSTVO in Russian No 5, May 83 pp 34-39

[Text by A. Bybochkin, Chairman, USSR State Commission for Reserves of Useful Minerals]

[Text] The mining industry of the nation will develop in the future based on new technology, technical-economic and mineral raw materials bases.

The November (1982) Plenum of the CC CPSU pointed out that the practical course toward increased effectiveness of social production, successful social-economic development of the nation is closely related to accelerated scientific and technical progress. Intensification of production, savings of all types of resources, including mineral resources, efficient and combined utilization of raw materials are possible only by utilization of progressive scientific and technical achievements in the mining and processing of mineral raw materials. Oil, gas, coal, ferrous and nonferrous metals are the basis of industry. The mining and processing of these raw materials requires complex and expensive equipment, which in the final analysis leads to an increase in the cost of the production of each unit of the end product. In old mining regions with well developed infrastructure and industry, processing and consuming the mineral raw materials, some of the industrial resources, particularly high quality and technological resources suitable for open pit mining, are largely exhausted. Processes of prospecting, combined evaluation and development of deposits, combined processing of ores and concentrates have been significantly complicated, leading to an increase in the cost of production. Over the past 20 years the mean depth of prospecting and producing oil wells has increased by a factor of two. In working a number of hydrocarbon deposits, due to anomolously high pressures and complex chemical compositions of fluids, special expensive anti-corrosive equipment and apparatus are required for prospecting boreholes, leading to an increase in costs. The industrial assimilation of such deposits involves great capital investments, the use of progressive waste-free technology, providing for high levels of extraction of methane, condensate, sulfur, carbon dioxide, ethane, propane, butane and aromatic substances from the raw materials.

Only a combined approach to these raw materials can allow effective processing and protection of the environment.

In recent years there has been a significant increase in the depth of the coal mines in the Donets Basin, mines in the Krivoy Rog Basin, Altay and the Urals, open mines at the Kursk magnetic anomaly, requiring the use of more complex and expensive mining equipment. Significant expenditures are necessary to preserve the environment and assure conditions of safe conduct of all types of mining operations. The scientists and specialists are countering increasing cost factors with further progress in geological science, new methods and techniques of prospecting, technologies of mining and processing of mineral raw materials, which should facilitate more complete utilization and study of the latest techniques, introduction to processing and working of deep useful minerals, expansion of their range and area of application, decrease in costs per unit of product produced. The development of nuclear power engineering, electronics, instrument building and other new branches of the national economy is unthinkable without stores of radioactive ores and rare earth elements.

The socialist law and planned system of operating the national economy create favorable conditions for combined geologic-economic evaluation of deposits and effective working of these deposits. Combined study, evaluation and utilization of mineral raw materials is a pressing problem. Its solution largely determines the successful development of balanced and highly effective economics, the well being of our own and future generations. With a significant growth in the mining and processing of mineral raw materials, the combined geologic-economic evaluation of prospected deposits, providing for the most complete utilization of mineral raw materials on an effective technological and economic basis takes on still greater national economic significance.

As the production of primary products increases, the capability of side product extraction of useful minerals - overburden - as raw materials for the construction industry increases, as does the possibility of utilizing valuable components located together with the primary product (accompanying rare and noble metals, scattered elements). Complete geologic-economic evaluation of deposits based on the latest achievements in geology, mining science, the technology of combined mining and processing of mineral raw materials, economics, including problems of cost formation and organization of production, supports the creation of geologically, technologically and economically well founded mineral material bases, the development of progressive plans for combined industrial assimilation of deposits and combined processing of mineral raw materials on an efficient technological and economic basis. The experience of the operation of leading enterprises in the ferrous and nonferrous metallurgical industries, combine processing of ores and concentrates of ferrous and nonferrous metals such as at the Zdanov metallurgical plant, Almalyk and Noril'sk mining and metallurgical combines, the Dneprovsk mining and metallurgical

combine and others shows that combined processing of raw materials can achieve signficant reductions in the cost of production, increasing the effectiveness of mining and processing of mineral raw materials by enterprises.

Combined utilization of mineral raw materials facilitates mutually favorable development of multiple branch production processes. For example, at the Almalyk mining and metallurgical combine copper cakes from a zinc plant are received for preparation of the charge at the copper melting plant directly as a slurry. The content of lead and bismuth in the slime of sulfate production from the copper smelting plant is sent to the lead cake drying department of the zinc plant, from which the useable lead, bismuth and noble metals are extracted. The sulfuric acid produced at the combine from the waste gases is used here for the production of fertilizers.

A broad range of products produced by the Noril'sk mining and metallurgical combine and Zdanov metallurgical plant imeni Il'ich is extensive. The operation of these plants features a high level of profitability, achieved by complete utilization and processing of mineral raw materials.

The Dneprovsk mining and metallurgical combine, together with the primary product, also produces significant quantitites of nonmetallic useful minerals valuable for the economy, significantly increasing the profitability of production and providing a large sum of additional income.

It is important in solving the problem of combined utilization of deposits and combined processing of mineral raw materials to provide a technological and economically well founded evaluation of the preparation of the deposits for combined industrial assimilation. Without this it is impossible to determine the economic expediency of combined development of deposits and working of mineral raw materials, to create a progressive technical plan for future mining and beneficiation on mining and metallurgical complexes, providing for complete utilization of mineral raw materials or to achieve multi-branch construction, cooperation within and among branches.

A scientifically well founded complete geologic-economic evaluation of a deposit is necessary also for determination of the actual economic effectiveness of geological prospecting operations, economically efficient limits of losses, composition of realistic state balances of mineral resources. Furthermore, it is difficult to establish economically well founded times of support for the corresponding branches of industry by balance (extracted for the oil industry) reserves, to develop principles of price formation - this is an important lever in the economic mechanism- for prospective reserves and, considering this, to establish direct independent financing relationships among geological prospecting institutions and the mining and processing branches of industry. Combined geologic-economic estimates of deposits are based on extensive volumes

of information, necessary for the development of progressive technical plans for combined extraction and processing of mineral raw materials. In particular, such estimates must give exhaustive and reliable descriptions of the form and conditions of deposition of useful minerals, their quantity and quality, mineral and chemical composition, balance of distribution of useful and harmful components among forms and their location, temperature conditions, engineering and hydrogeological conditions of working of the deposits, technological and technical-economical indices for combined development of deposits and combined working of mineral raw materials, expected cost of the main product and products produced from secondary raw materials or wastes from processing of the main product, considering the effective wholesale cost for extraction cost, capital investments for combined assimilation of deposits, including the cost of fixed capital, etc.

One important element in combined geologic-economic evaluation of mineral raw materials is technical and economic foundation of the establishment of conditions in which all requirements for the quality of the mineral raw material are observed. Conditions in the broad understanding of their significance should reflect first of all the geological, mine engineering, technological and economic situation at the deposit for its combined development and combined working of mineral raw materials. With combined geologic-economic evaluation of deposits considering the effective wholesale prices or extraction prices one must keep in mind not only the basic, but also the secondary useful minerals and components which will facilitate an increase in the economic potential of deposits worked. For example, in geologic-economical evaluation of deposits of solid useful minerals it is desirable to consider the volume of overburden rock which must be removed - the initial raw material for the construction industry, as well as useful components which may be present as well; for oil deposits one should consider the value of sulfur, metal components, paraffin, side product natural gas, as well as condensate, helium, ethane, propane and butanes; for gas deposits - oil around the peripheral portion of the deposit, sulfur, condensate, helium, ethane, propane, butanes, aromatic hydrocarbons.

A complete geologic-economic estimate of a deposit, based not only on its primary components but also on side products (including the overburden rock) significantly increases the economic potential of reserves, helping to reduce losses in the beneficiation and metallurgical finishing, creating favorable prerequisites for extraction of deposits, the working of which based on the main component might be hardly profitable or even might show a loss. Calculations have shown that lean iron ore in Urals deposits could technologically and economically produce conditioned magnetite, pyrite and copper concentrates more cheaply than transporting them to the Urals as is now done. Complete working of these deposits with slight capital investments could significantly supplement the raw material base for enterprises of the ferrous and nonferrous metallurgy industries in the Urals and at least partially avoid the transportation of copper

and iron concentrates from the European portion of the USSR and Kazakhstan.

Decisive factors in complete geologic-economic evaluation of the preparation of deposits for complete industrial assimilation include technological and economic factors. The technological factor is the basic element in the geologic-economic evaluation of deposits. Progressive technology for combined development of deposits, beneficiation and metallurgical conversion of ores and concentrates helps to increase the extraction of useful components, complete utilization of mineral raw materials. Without performing complete technological research in the stage of prospecting of deposits, studying representative samples, the results of which should be used in the planning of beneficiation plants and metallurgical plants for complete processing of mineral raw materials, it is impossible to completely utilize a deposit and process all of the mineral raw materials encountered in it on an efficient economical basis. A number of examples have been known in which, due to low quality of research on beneficiation of complex ores, planned extraction industries of basic and secondary components were not achieved for the production of the corresponding concentrates (Kovdorskiy mining and beneficiation combine, etc.) which, doubtless, would cause a loss to the national economy.

Also, successes in modern technology, complex development of deposits and processing of mineral raw materials at a number of leading enterprises have yielded significant economic effects by side production of other products. For example, in nonferrous metallurgy the total value of products produced as side products, including such valuable metals as germanium, selenium, indium and others, represents more than 20 percent of the total value produced. Depending on the form of bonding with various ore forming minerals, some rarely encountered nonferrous metals (cobalt, bismuth, etc.) and noble metals may have varying industrial significance. Thus, in the copper pyrite ores of the Urals we find cobalt, bismuth, silver, gold, etc. Some of these components are bonded with copper-containing minerals and their extraction as commercial products should be performed during metallurgical processing of the copper concentrates. Others, sometimes most, are contained in pyrite and should be extracted during processing of the pyrite concentrates.

However, the problem of combined processing of pyrite concentrates, like that of apatite, nepheline and other concentrates, either has not been solved at all, or has not been completely solved. Still less work has been done on the technology of deep beneficiation of combined ores at a number of enterprises in ferrous and nonferrous metallurgy, the production of phosphorus fertilizer; the wastes of beneficiation of metallurgical and chemical processes are insufficiently utilized. The now broadly used technology of beneficiation of ores and conversion of concentrates require significant improvement and gradual replacement by waste-free technologies.

Without reducing our attention toward combined and effective utilization of mineral resources, we must provide the maximum complete extraction of the basic components defining the potential of prospected deposits. At the scale of extraction of commercial ore and production of commercial concentrates which has been achieved, increasing the extraction of the main ore forming components (and for oil and gas condensate deposits - increasing the extraction factor of petroleum and condensate) into the end product would be equivalent to discovery of new deposits, requiring great expenditures for prospecting and commercial assimilation.

It is particularly important to extract more completely the oil, gas, condensate and from them valuable components such as sulfur, helium, ethane, propane, butane, mercaptans and metals.

At the present time more than half of the fuel and energy balance of our nation is covered by oil, about a fourth by coal. In prospecting deposits of hydrocarbon raw materials the most important task is proper evaluation not only of balance, but also of extracted reserves. The methods currently used allow us to evaluate balance reserves more reliably than extractable reserves. Therefore one of the most important tasks of science is to arm our practical specialists with effective methods to estimate the extraction factor of petroleum and condensate from the earth, i.e., methods allowing with great accuracy determination of technologically realistic and economically possible extracted reserves of oil and condensate. This requires significant improvement of methods of searching and prospecting for oil, gas and gas-oil deposits. To increase the rates of prospecting while further improving the reliability of combined evaluation of balance and extractable reserves, scientific and technical revision of the geophysical methods, their replacement with more effective ones providing for the production of highly reliable quantitative and qualitative information on the structure of deposits and potential for their exploitation will be required. In particular, as vibration seismic methods of prospecting are introduced, the effectiveness from these methods will be greatly increased, drilling of expensive and nonproductive contouring boreholes will be greatly reduced.

To solve the new methodological, technological and technical-economic problems directed toward increasing the coefficient of petroleum extraction and, consequently, the fraction of extracted reserves from the balance reserves, for further growth of oil output under more difficult natural and geological engineering conditions, in the next few years we must develop and introduce highly effective methods to act artificially on strata (MIVP), concerning which we read excellent reports by both Soviet and foreign scientists and specialists. In the USA, for example, the fraction of oil extracted using these methods amounted to 4 percent of the total in 1982, as opposed to 2 percent in 1973. Based on estimates by foreign experts, MIVP can be used to increase the oil output factor from 30 to 40 percent, allowing extraction of an additional 18 billion barrels of oil from existing deposits.

The use of artificial methods of acting on a stratum is not a simple matter, and is expensive. Based on preliminary calculations by scientists and specialists of the oil industry ministry, the cost of 1 ton of oil extracted by MIVP will be higher than the cost of oil extracted by ordinary methods, but this oil will cost less than oil extracted from newly opened small deposits.

The basic principle of socialist natural resource utilization is clearly formulated in the resolutions of the 26th CPSU Congress. "Apparently a new approach is needed to the extracting industries in general," ... it is stated, "...the successes of the entire economy will depend to a great extent on increasing the effectiveness of the natural resource extracting industries. The path toward this is acceleration of scientific and technical progress, combined, deep processing of useful minerals, broader application of secondary resources.

The pressing nature of these problems is related to the fact that we are concerned with riches which can never be replaced. Their proper, efficient utilization is our responsibility not only to our own generation, but also to future generations. And no one has the right to forget this."*

The resolutions of the 26th CPSU Congress represent a strategic line in the rational and combined utilization of natural resources. In our nation the conservation of nature is a special type of economic activity, planned on the statewide scale. The progressive growth of costs of natural resources indicates their tremendous natural economic significance. At the same time,effective utilization of natural resources is one of the most effective factors in increasing the economic potential of the nation. The need therefore arises to develop a single, long term, goal-oriented complex program for rational and complete utilization of mineral resources considering the preservation of the environment. Nonrational, incomplete utilization of mineral resources has an economic cost. The problem must be solved, particularly by using useful minerals brought up as side products and production wastes for the economy. In the opinion of specialists, there is at the present time no basic technological difficulty in the industrial utilization of a large portion of the raw materials and wastes from the mining, metallurgical and chemical branches of industry.

In recent years enterprises have appeared with increasing frequency where the production processes are based on principles of waste-free technology. These enterprises are successfully using overburden and the wastes from beneficiation, producing significant profit and preserving the environment from pollution. However, the use of secondary useful minerals, frequently not those for which the production process was designed, in many cases seems unsuitable at first glance, since it worsens the technical and economic results of the primary production process, since the content

*Materials of 26th CPSU Congress, Moscow, Politizdat Press, 1981, page 41.

of secondary useful components is usually quite low, and their extraction requires expensive equipment. Although the wholesale prices for mineral raw materials introduced in 1982 stimulates maximum combined utilization of mineral resources, combined and deep processing, a number of secondarily produced products are still gained using as a basis the wholesale prices for primary mineral raw materials not requiring expensive technology for additional processing. For example, in estimating the effectiveness of production of cobalt from cobalt containing pyrite in iron ore or copper pyrite deposits, we must not use the wholesale costs for cobalt and its compounds extracted from sulfide copper-nickel ores. Of course, cobalt and compounds which contain it, obtained in combined processing of cobalt-containing pyrites, must have their own wholesale prices.

An important role in combined assimilation of deposits and useful minerals should be played by the system of economic evaluation of minerals and all other natural resources now under development.

6508
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EFFECTIVE UTILIZATION OF RUDNYY ALTAY ORE DEPOSITS

Moscow IZVESTIYA in Russian 12 Jul 83 p 2

[Article by A. Protozanov, First Secretary of the Eastern Kazakhstan Party Obkom, Deputy of the USSR Supreme Soviet: "The Miserly One Pays Double"]

[Text] Tomorrow's great profit does not appear from nowhere. It must have been prepared today. Once again this proves the situation which occurred in the mining and metallurgical sectors of Rudnyy Altay. In the late 60's and early 70's, some specialists began championing the idea that the mineral wealth of Eastern Kazakhstan Oblast was being exhausted. This led to the conclusion that Rudnyy Altay had no great future, and would have to leave the proscenium of the country's mining industry. The Metallurgical and enriching plants built here would have to be converted gradually to be provided with imported raw materials.

However, directly opposing views were expressed at the same time. The most experienced geologists considered that the mineral wealth of the whole of Rudnyy Altay was not exhausted, but only of those deposits which were discovered long ago. So long as the prospecting means were insufficiently apportioned over a long period of time, they were managed accordingly. And if so, then prospecting work must be sharply increased, it must be given a wide scope, and conclusions drawn only after diligent testing. The oblast's position then found the full support of the Kazakhstan Communist Party Central Committee, deep understanding in the country's planning organs, and in the Union Ministry of Geology. Prospecting work in Rudnyy Altay began gathering strength. Whereas in the 8th Five-Year Plan 115 million rubles were spent for prospecting, now 250 million were appropriated for the current plan.

Now it may be said with satisfaction that the calculation of the conjectured resources of Eastern Kazakhstan Oblast proved truer than could be expected. The collective of one of the better associations, Vostokkazgeologiya, headed by an energetic, innovative specialist, L. Trubnikov, refused to believe the earlier notion of Rudnyy Altay's decline of mineral wealth. Over a period of several years reserves of raw materials for nonferrous metallurgy were discovered, the likes of which were never known in the history of this rich kray.

However, even the kray's riches, which have now been officially confirmed and admitted by all, more than exceed the demands of nonferrous metallurgy and would enable the production here of a large quantity of high-quality lead

and zinc. But so far this has not happened. On the contrary, the output of some types of extremely vital products has even decreased recently. What is the matter? One of the main reasons is that, while new deposits were being put on geological maps, confirmed and coordinated, metallurgists had to "sort out" the old ones. And the old ones were not the same as they had been many years before. Ores, left "for the balance" as not promising, contained few basic nonferrous metals.

It was necessary to use what was there. But how to use it? To extract a decreasing amount of lead and zinc from ores, leaving other components in heaps as before, or return to the comprehensive use of raw materials? The oblast chose the second method.

This required the tremendous, laborious work of thousands of people. Metallurgists, miners, enrichers in close cooperation with scientists of many institutes, primarily the All-Union Scientific Research Institute of Nonferrous Metallurgy in Ust-Kamenogorsk, with the constant support of party and soviet organizations, developed a number of new production processes to extract components other than lead and zinc from ores. This work was performed on a particularly large scale in the Ust-Kamenogorsk lead and zinc combine imeni V. I. Lenin. Created in its time to produce only two metals, year after year increasingly newer ones were added to it. The experience of the best enterprises proved so important for the country that the CPSU Central Committee in 1972 made a special resolution "On the work of the party organizations of the Ust-Kamenogorsk lead-zinc and Balkhash mining-metallurgical combines for mobilization of the collectives to achieve high indicators in the comprehensive use of ores."

Now the lead-zinc combine produces, instead of two types, some 23 types of commercial products. In a monetary sense, the so-called "byproducts" constitute more than half of the cost of the basic metals. Rudnyy Altay's deposits alone now yield the 42 elements of Mendeleyev's Periodic Table.

But the difficulties of the past years have convinced us otherwise. The substitution in economics of tactics for strategy may lead to serious losses. The objective nature of the economic laws of socialism, Comrade Yu. V. Andropov emphasized in an article published in the journal "Kommunist", requires avoidance of any form of attempts to control economics by methods foreign to its nature. Apparently, some specialists 15-20 years ago were guided by good intentions, decreasing the funding of geological prospecting. The aim was to conserve the resources today. But it is not badly put that the miser pays double. Having available, as now explained, the richest reserves of local raw materials, the metallurgical enterprises began bringing ore concentrate from afar, including from abroad. And this greatly exceeded the expenses, which were required opportunely for the development of Rudnyy Altay's raw material base.

It would seem that so serious a lesson would entail the sound conclusions of the planning organs and trade ministries. Unfortunately, the Eastern Kazakhstan enterprises of nonferrous metallurgy still work mainly on expensive imported raw materials, which are poorer than the local resources and are accompanied by interruptions.

Four of its mines, for example, serve the Zyryanovsk lead combine. The ores are poor here, and are in short supply. Part of the raw materials must be conveyed by railway from Central Kazakhstan. Meanwhile, nearby are two large deposits--the Grekhov and Maleyev. Their ores are rich. Three-quarters of the Maleyev deposit's reserves contain almost four times as much metal as the present raw materials. In order to extract such wealth, some tens of millions of rubles must be allocated by 1990 to develop the deposit. It is no small sum. But the expenses will be repaid in only 3 years, and then the state will receive a clean profit, provided of course, that it is done under conditions of intense development and not as it is managed in the neighboring Grekhov deposit. Here the USSR Ministry of Nonferrous Metallurgy since 1977 has allocated only 15 million rubles for work which was projected to cost 78 million. How much time will it take to reach the treasure, if the Ministry of Nonferrous Metallurgy allocated the builders less than 1.5 million rubles for this year?

This is roughly the picture at the Irtysh Polymetallic Combine. Its copper-smelting plant has three mines: the Irtysh, Berezov, and Belousov. Since their ore is in short supply, additional raw material must be brought in by motor vehicle. Soon the situation will become even more complicated. The reserves of the Belousov mine are rapidly decreasing. There is a way to replenish them. The Yubileyno-Snegirikhinsk deposit, whose rich ores can reliably supply the combine for many years, was prospected in 1975. But so far the Ministry of Nonferrous Metallurgy has not begun development of this promising deposit.

The Leninogorsk Polymetallic Combine, one of the country's oldest, finds itself in an analogous situation. Its old sources of raw material are becoming increasingly scarce. There is a solution: to more rapidly develop the two unique deposits prospected by geologists--the Novo-Leninogorsk and Chekmar. Especially since, in the latter, half of the reserves can be extracted by the inexpensive open method, and the former, with easily enrichable ores and containing four times as much metal as the present ores, is adjacent to the combine's walls. However, even here the Ministry of Nonferrous Metallurgy has been slow to allocate funds.

The Ministry's position in relation to the raw material base for Ust-Kamenogorsk Titanium-Magnesium Combine is especially startling. One of the largest in the country, the combine requires many raw materials to produce scarce metals. They are brought in from the Urals, the Ukraine, and even from abroad, even though the large Karaotkelsk deposit, opened more than 10 years ago, is really quite close, in the same oblast. Its resources are sufficient for the titanium-magnesium combine to expand even for a century. But again the Ministry still has not touched it. The fact is that the nucleus of the deposit, represented by the raw material for nonferrous metallurgy, as if enclosed in the covering of a feldspar, is a very scarce product in a number of other sectors. Therefore, comprehensive use of the reserves is required. However, the USSR Ministry of Nonferrous Metallurgy conserves its money, the Union Ministry of Commercial Building Materials saves its money, although it also needs the deposit's riches, and, investing money in its development, it will soon be generously repaid. Meanwhile the state bears great expenses.

Specialists at any level, not to mention chief staff workers of this or that sector, should have the ability to examine tomorrow's profit and today do everything to realize it. But how much time was wasted while the USSR Ministry of Nonferrous Metallurgy evaluated, for instance, the profit of processing cold slag of metallurgical production. The mountains in the oblast accumulated this. It exceeds the rich mined ores in the content of nonferrous metals. Our scientists and engineers of metallurgical enterprises created an effective method of processing cold slag. Testing it in various conditions, they requested the USSR Ministry of Nonferrous Metallurgy to build a rotary-kiln complex for smelting metal from wastes. But for a long time the sector's staff declined to admit the advantage of the proposal, and, naturally, did not hasten to provide funding for its implementation. Now, all the same, this complex is being built in Leninogorsk. As it is said, they returned to the furnace, from which one had to dance at once and not deprive the country of the chance to obtain the needed metal, in point of fact, gratis for many years. Indeed, the cover of expenditure of such a complex is in all 6 months.

Of course, we must save the peoples' kopecks. But aren't they sometimes similar in the industrial departments and planning organs to the miser, who then has to pay double? In mineral wealth Rudnyy Altay is one of the unique regions of the world. Here can be found a highly developed mining, enriching and metallurgical industry, on whose base whole towns grew up long ago. Here is a diverse army of qualified workers and specialists, and many scientific and design-development establishments, including the powerful All-Union Scientific Research Institute of Nonferrous Metallurgy. In a word, the kray is multilaterally developed and, in addition, the richest in resources. Unfortunately, we still do not dispose of them wisely. It is thought that we must first use those reserves that we already possess and which will allow the country to obtain the greatest return in the shortest time for the least amount of money.

12421
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KURSK MAGNETIC ANOMALY: PROBLEMS IN FORMATION OF TERRITORIAL-INDUSTRIAL COMPLEX

Moscow IZVESTIYA in Russian 1 Jul 83 p 2

[Article by N. Garmashov, Secretary of Belgorod CPSU obkom, in column: "Put CC CPSU June Plenum Resolutions Into Deeds!": "Setting for a Pearl", subtitled "Fuller Use Resources of Kursk Magnetic Anomaly"]

[Text] What is the KMA? It is a huge region, hundreds of square kilometers, where the largest known deposits of iron ore on earth are located. One-third of the raw materials resource balances for the country's ferrous metallurgy enterprises are stored in this unique storehouse.

Currently the Kursk Magnetic Anomaly Territorial-Industrial Complex (TIC) consists of three production centers being formed, two of which--the Oskol'skiy and Belgorodsko-Yakovlevskiy--are in Belgorod oblast, and the other, the Zheleznogorskiy--is in Kursk oblast. The complex has a clearly defined goal: to create a reliable raw materials base for ferrous metallurgy in the center of the country. The mining enterprises of the Belgorod oblast only--the Lebedinskiy and Stoylenskiy mineral-dressing combines, and the KMAruda combine--annually extract more than 40 million tons of raw ore and produce about 23 million tons of commercial grade ore. The ore is shipped to Lipetsk, Tula, Cherepovets, the Urals and Western Siberia. The oblast's percentage of national production of commercial grade iron ore grew from 5.5% to 9.9% during the last ten years. More than 200 million tons of high quality raw materials have been already shipped to metallurgical enterprises of the country.

The role and significance of the KMA TIC in the economy of the oblast increase every year. This is expressed not only by increases in the production volume and commercial grade ore shipments, but also by the improvements in the territorial organization of production, location of productive forces, efficiency of capital investments, and acceleration of tempo of labor productivity. And after start-up of the "first-born" of the national blast furnace-less metallurgy--the Oskol'skiy electrometallurgical combine imeni L. I. Brezhnev--our oblast will also become a large supplier of electric steel and rolled ferrous stock. At the end of the last year the oxidized pellets shop yielded its first products. During the current five-year plan a steel foundry and a rolling mill will be started up.

However, the favorable possibilities of the KMA field in the Belgorod oblast are not being fully exploited. The isolation of departments, dispersal of funds, and unbalanced plans are all very much in evidence.

In his speech at the June (1983) CC CPSU Plenum comrade Yu. V. Andropov emphasized: "...first of all we should put in order what we already have, ensure the most reasonable use of the production and scientific-technological potentials in the country..." Let us look from this viewpoint at the KMA potential. The presence of twelve explored sites with huge reserves of iron ores, an extensive transportation network, a large construction industry base, and the favorable geographic location of the field will make it possible to develop an industrial mining complex capable of producing yearly 100 to 120 million tons of raw ore and 60 million tons of commercial grade ore. But so far there is no all-inclusive scheme for the development and placement of the industrial enterprises from now to the end of this century.

It has to be especially underlined that the prospects of TIC formation and the intensity of the utilization of the KMA mineral resources depend to a great extent on the rate of development of the Yakovlevskiy iron-rich ore deposit. Its exploitation will make it possible to define the main direction according to which future development and utilization of iron ore reserves in technically and hydrogeologically complex great-depth mining conditions can take place.

The experience gained in the construction of the giant Yakovlevskiy mine will make it possible to build in the region a series of subsurface mining enterprises requiring substantially reduced energy consumption per ton of product while at the same time preserving tens of thousands of hectares of the Central Chernozem (black soil) fertile lands. But the rate of construction of this unique mine does not even remotely correspond to its significance in the further development of the KMA. Thus, during the nine years of its construction only one-third of the funds earmarked for the project have been allocated by the USSR Minchermet (Ministry of Ferrous Metallurgy). If the mine continues to be constructed at this same rate, we will be able to open up this richest storehouse no earlier than the next century.

The present state and prospects of development of the KMA TIC will require a qualitatively new approach to the problem of full utilization of the field's mineral resources. These resources include colossal deposits of non-ore fossils: chalk, sand, clay, marl and crystalline slate. Currently up to 40 million cubic meters of rock are being transported annually to the dumping grounds during stripping operations, with only a fifth of the useful components being removed. By the end of this millenium the "Mont Blanc's" of stripping rock will grow yearly by 100 million cubic meters of the most valuable mineral raw materials that should have been used for the needs of the TIC.

Let us consider crystalline slate. A valuable gravel material results from its processing which costs no more than two rubles per cubic meter. At the same time about three million cubic meters of gravel costing six to eight rubles per cubic meter are brought yearly from the southern parts of the

country into the Belgorod oblast alone. Furthermore, one should not fail to take into account that by 1985 the expected shortage of non-ore construction materials in the TIC will be about ten million cubic meters. But in the long-range outlook it is possible to produce more than ten million cubic meters of cheap gravel and sand for the needs of the whole Central Chernozem economic rayon from the dumps of the Stoylenskiy, Lebedinskiy and Mikhailovskiy mineral dressing combines only.

Then what is holding back the inclusion of the KMA mineral treasures into economic use? First of all, the planning of the utilization of iron ore deposits based on the industrial sector principle, which leads to the irretrievable loss to the national economy of non-ore fossils. An important step toward overcoming the departmental barriers is, to be sure, the "1981-1985 Target Program of the Scientific Research and Project Work on Complex Utilization of the Stripping Rock from Open Mines and Wastes of Enrichment Factories of the Kursk Magnetic Anomaly in the National Economy." This program provides for design and construction in the 1980's of four units to process clay, crystalline slate and the wastes from enrichment factories: crushing and grading mills at the Lebedinskiy gravel production combine, tailings' grading at the enrichment factory of the Stoylenskiy combine, and a porous clay filter plant at the Staryy Oskol.

Realization of the outlined program will make it possible to lower the cost of commercial grade ore and locally produced construction materials, and will aid in protecting the environment. Expenditures for the target program will be about 3.5 million rubles, but its economic effect will exceed 400 million rubles. It is worthwhile to work together on such a profitable project. And this applies most of all to the ministries of ferrous metallurgy, construction materials, and geology. But it is precisely these ministries which unfortunately have not distinguished themselves by any special activity toward solving such an important problem of the national economy.

Just one example. Gosplan committed the Minchermet and the Minstroymaterialov (Ministry of Construction Materials), and appropriate scientific research and design institutes to complete the general development plan for the construction materials industry of the KMA field within the next year, with provisions for processing stripping rock and enrichment factory wastes taking into account the mining enterprises, both new and under construction, in the region. However, the initial results of the work in this direction have not been very optimistic.

It is difficult to imagine the further development of the KMA TIC without a clear program for its water supply. Because major parts of the Oskol'skiy electrometallurgical combine are being put into operation this problem has now become one of the most pressing. When the entire capacity of the hearthless giants is reached, more than 300 million cubic meters of fresh water will be irretrievably lost each year. This holds true even under conditions of switching to a more economical technology of iron ore enrichment and pelletizing. In short, within the next few years, and especially after the present decade, additional reliable sources of water for the complex will be needed.

In line with this, a more detailed Oka-Don-Oskol canal construction project has been worked out. We think that it is time for the appropriate departments to give their approval for this project and to begin implementation. We hope to receive the water resources from underground and surface water for the KMA field from the Ministry of Melioration and Water Resources this year. Since it is difficult to run such a huge construction project without being sure of a stable water for mineral dressing and metallurgical production.

Furthermore, one must also take into account such factors as changes in the hydrogeological regime of the Oskol'skiy industrial rayon and its surroundings as the result of vigorous economic activity at the KMA. Local measures taken to decrease air and water pollution, to switch enterprises to wasteless and waterless enrichment technologies and to utilize and process industrial wastes have not been entirely successful. An integrated system for managing the ecological situation is required. The development of the KMA TIC has reached the stage where it is impossible to treat separately just a single facet of the economic activity in this vast economical region in the center of Russia.

The first stage in the creation of TIC showed that the greatest losses occurred where there was no clear system of scientific substantiation, planning and management of the economical, social and ecological processes in the region. Therefore, the time has come to work out a long-range program of national economic goals for development of the KMA TIC providing concrete tasks for ministries and departments that participate in its formation.

12421
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UDC 541.18.056

NEW ELECTROLYTIC METHODS OF PRODUCING HIGHLY DISPERSED METAL POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 83 (manuscript received 20 Apr 82) pp 5-9

KHIMCHENKO, Yu. I., FIL'T, I. and KATSYUK, O. A., Institute of Colloidal and Water Chemistry imeni A. V. Dumanskiy, Ukrainian Academy of Sciences

[Abstract] New electrochemical methods have been developed for producing dispersed metals in which traveling magnetic fields and ultrasound are applied to the process. The authors have developed an electrochemical method for producing highly dispersed metal powders by electrolysis of aqueous solutions of their salts using surfactants dissolved in organic solvents with a variable traveling magnetic field of 0.1-0.3 teslas used in the process of electrolysis. The device for electrolytic production of ferromagnetic metals and alloys and on electrolyzer with cooling jacket and nonequiaxial ferromagnetic bodies for precipitation of nonferromagnetic metals and alloys are diagrammed. Electron microscope photographs are presented of iron powerders produced in a two-layer electrolytic bath, traveling magnetic field with nonequiaxial ferromagnetic bodies and by an electroemulsion method. The new continuous electrolytic methods for producing highly dispersed metals, in contrast to two-layer electrolytic bath methods, produce powders which are not dangerous in terms of fire or explosion, are waste-free and utilize processes which can be fully automated. Figures 4; references 5: all Russian.
[153-6508]

UDC 621.762.5:621.763

CONTACT PHENOMENA IN POROUS FIBER MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 83
(manuscript received 15 Jul 82) pp 51-56

KOSTORNOV, A. G. and GALSTYAN, L. G., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] Due to the significant volumetric growth effects of fiber briquettes during pressing and sintering in the process of manufacture of precision complex shaped products, repeated processing or at least calibration

is virtually unavoidable. This article estimates the changes in status of contacts between particles in this process. To study contact phenomena in plastically deformed fiber objects the method of electric conductivity was utilized with continuous specimens measuring 5 x 7 x 90 mm made of nichrome fibers 50 μm in diameter and 3 and 6 mm in length. Though repeated pressing reduced the porosity of briquettes of short fibers by only 0.5%, of long fibers by 1%, the quality of contacts after final sintering improved by an average of 11.5 and 15.5%. The briquettes thus produced were plastically deformed by various forces in the direction of the previous pressing. The compacting curves of the sintered specimens are presented. Significant plastic deformation of well-sintered porous fiber bodies was found to break down the contacts in the material, significantly decreasing strength. Upon oxidation of fiber bodies, contacts between particles are most affected during the initial stage of oxidation. Sintering does not cause catastrophic failure of contacts between fibers. Figures 4; references 11: all Russian.
[153-6508]

UDC 621.762.047

SELECTION OF COMPRESSION CONDITIONS FOR PRODUCTION OF MULTILAYER STRIPS BY ROLLING OF COMPACT METAL WITH POWDER LAYER

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 83
(manuscript received 21 Apr 82) pp 14-17

VOROPAYEV, V. S., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] During rolling of a compact metal with a layer of powder, the problem arises of proper selection of conditions of compression and roll diameters for production of a quality layer of compacted powder. It is assumed in this article that the base of compact metal is not deformed, only the powder layer being compressed. An equation is derived to define the conditions of compression allowing production of a continuous coating during rolling of a compact metal with a layer of powder. Figures 2; references 5: all Russian.
[153-6508]

UDC 669.295.5:539.55/56.669.788

INFLUENCE OF HYDROGEN ON FRACTURE TOUGHNESS AND SUBCRITICAL CRACK DEVELOPMENT IN ($\alpha+\beta$)- TITANIUM ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 19, No 3, May-Jun 83 (manuscript received 25 May 81) pp 3-8

KOLACHEV, B. A., FISHGOYT, A. V. and GRINBERG, V. A., Moscow Aviation Technology Institute imeni K. E. Tsiolkovskiy

[Abstract] An attempt was made to construct a general model of the influence of hydrogen on the parameters of subcritical crack development in titanium and its alloys. Hydrogen brittleness occurs by different mechanisms for different concentrations of hydrogen in the material. The scale of hydrogen concentration should therefore be broken down into a number of sectors, in each of which the development of hydrogen brittleness is controlled by a different mechanism. Estimates of crack growth rate using an equation derived in this article yield differences of three orders of magnitude depending on the assumptions made concerning the specific mechanism. A stricter evaluation requires additional experiments to determine the validity of the various assumptions. Figures 1; references 13: 9 Russian, 4 Western. [156-6508]

UDC 620.194

PROSPECTS FOR USING TITANIUM ALLOYS TO MANUFACTURE HYDROCHLORIC ACID YEAST HYDROLYSIS APPARATUS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 19, No 3, May-Jun 83 (manuscript received 7 May 82) pp 84-88

MELEKHOV, R. K., KOVAL', M. V., KRUTSAN, A. M., BLASHCHUK, V. Ye., and ZYKOV, A. V., Physico-Mechanical Institute imeni G. V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] An attempt was made to develop a foundation for the expediency of using highly corrosion resistant titanium alloys as structural materials for hydrochloric acid hydrolysis of yeast, to allow enameled apparatus to be replaced with welded metal apparatus. Tests were performed on tubular specimens using a special program which imitated true operating conditions

including start-up, operation and shut-down, as well as changes in operating modes. It is concluded that it is desirable to use the β alloy 4201U, with its superior corrosion resistance and corrosion cracking resistance, instead of α' alloys. Welded joints in the alloy made by argon arc welding using wire of the same composition as the base metal are structurally homogeneous. Deformation of 4201U by rolling and annealing at 1123°K increases its corrosion cracking resistance. Figures 4; references 8: 7 Russian, 1 Western. [156-6508]

MISCELLANEOUS

EARLY COMPLETION OF THE URENGOY-POMARY-UZHGOROD GAS PIPELINE CONSTRUCTION PROJECT

Moscow METALLURG in Russian No 5, May 83 pp 4-5

[Text by S.V. Burmistrov, Central Committee, Union of Metallurgical Industry Workers; M.A. Sidorov]

[Text] The workers at machine building, construction and installation enterprises, the workers of other areas participating in the construction of the most important object of the Eleventh Five-Year Plan - the Urengoy-Pomary-Uzhgorod main gas pipeline, have demonstrated patriotic initiative in supporting its timely completion. A significant role in the performance of this important economic and political task has been played by the workers of the ferrous metallurgy industry, delivering large volumes of pipe, rolled materials, metal products and other types of products for the construction of gas pipelines, compressor stations, etc.

In response to the Party's call to start up the Socialist competition for timely and high quality support of assignments related to the construction of the major gas pipeline, the workers at the Volga Pipe Plant, entering into Socialist competition under the slogan "From the Team to the Sector and the Shop, High Quality Products!" have comprehensively utilized the available reserves for saving metal, have obligated themselves to manufacture an additional 4,000 tons of large diameter pipe above the Five Year Plan. They will reach the planned capacity of the multi-layer pipe shop three months ahead of schedule and produce 1,000 tons of high strength pipe above the plan before the end of the Five Year Plan, the workers at the Vyksunskiy metallurgical plant have decided.

The workers at the Khartsyzsk pipe plant, in cooperation with VNITI Institute, metallurgists of the Novolipetsk, Cherepovetsk and "Azovstal'" plants have decided, by further improvement of technology and the organization of labor, to decrease the standards for consumption of metal, increasing the production of metal which passes acceptance testing so that by the end of the Five Year Plan an extra 24,000 tons of cold resistant pipe in "northern form" will be produced. Increased Socialist obligations for early delivery of high quality pipe in strict accordance with the

delivery requests have also been taken on by the workers at "Lentrublit" pipe plant.

Particular attention has been given by the participants in the competition to timely and complete fulfillment of orders for the construction of the gas pipeline, acceleration of the production of gas pipe with external anticorrosion coatings, oil pipe of cold resistant and anti-corrosion types of steel, as well as an increase in the quality of casing, drilling and pumping-compressor pipe.

During the course of the competition the workers of the Pervoural'sk pipe plant have successfully filled an important order for the delivery of hot rolled high strength pipe for compressor stations. Timely delivery of high quality products has allowed the builders of the "Urengoy-Pomary-Uzhgorod" gas pipeline and gas compressor plants to meet their planned assignments for 1982.

A significant contribution to successful fulfillment of the important assignments for delivery of main gas pipeline products was made by the workers in the Communist labor teams of pipe rolling installation 3-102, headed by foreman Victor Glebovich Lyadov. In the team of V.G. Lyadov each worker has mastered several related professions, leading methods and approaches of labor are being successfully introduced, every member attempts to take part in the development and introduction of new equipment, the performance of measures for reconstruction of production. In the team of Communist labor cases of disruption of labor and technological discipline have been eliminated, as well as disruption of general public order. The team of V.G. Lyadov completed its obligations taken on in honor of the jubilee year on 30 December 1982. Some 1,233 tons of pipe were rolled above planned, 324 tons of standard fuel were saved, 165,000 kw x hr of electric power were saved and 69,000 rubles were credited to the personal account of the team.

Competing under the slogan "Sixty solid weeks for the 60th Anniversary of the USSR," the team of the Pervouraz'sk new pipe plant has fulfilled its annual plan for implementation of production by 100.2 percent, increasing the probability of labor by 2.2 percent, over 30 percent of all products have been produced in the highest quality category, over 5,000 tons of pipe have been additionally produced. It has been awarded with the traveling red banner of the CC CPSU, USSR Council of Ministers, All-Union Council of Trade Unions and Central Committee of the Komsomol with a certificate of honor on the All-Union Board at the Exhibition of Achievements of the USSR economy for successes based on the results of the All-Union Socialist Competition for honorable celebration of the 60th anniversary of the USSR.

The workers at the Khartsyzsk pipe plant completed an important order by 25 December 1982. They have produced over 6,000 tons of additional large diameter pipe from metal saved for the most important construction

project of the Five Year Plan. The success of these workers is the result of goal-directed work by the administration of the plant and the union committee on the introduction of new equipment and technology and leading experience. In 1982, 21 measures for the use of new equipment were introduced at the plant, 16 schools of leading labor method were conducted, with the participation of over 300 persons. The best results in the production of gas pipe have been achieved by the traveling combined team of Leonid Petrovich Timoshenko, which welded 4,578 tons of pipe above the plan. The best pipe welders were D.A. Balyuk, A.M. Garus, A.A. Kravtsov, V.M. Masliyev, who completed their annual plan in November of 1982.

During the course of the competition by agreement on the principle of the "working relay race," the pipe rolling plants have produced more than 3.5 million tons of strip from the metallurgists of Cherepovets and Lipetsk and successfully filled an important order for delivery of large diameter pipe.

The fellows of VNITI Institute, in cooperation with the workers of metallurgical and pipe plants have performed a number of important scientific research works on the improvement of technology of pipe production designed for main line gas pipelines.

At the Vyksunsk metallurgical plant, multi-layer large diameter pipe has been put in production for high pressure gas pipelines. This product has no equals. For the first time in world practice the pipe is not rolled, but rather assembled from individual envelopes coiled up of 5 or 6 layers of low alloy steel. Pipe assembled from the multi-layer pipe sections can transport gas at pressures of 10 to 12 MPa (100-120 atm), doubling the throughput of the energy arteries of our nation.

Means for increasing the reliabilty of operation of oil and gas pipelines and the experience in their production have been studied and popularized at the All-Union Interplant School conducted in October of 1982 at Chelyabinsk pipe rolling, Volga, Novomoskovsk and Khartsyzsk pipe plants.

The participants in the schools reported that during the years of the 10th Five Year Plan at the enterprises of this branch of industry, thanks to the introduction of both organizational and technical measures, redesign and modernization of equipment, introduction of new facilities, active participation of labor teams in Socialist competition, the production of pipe has increased by 14.5 percent, particularly the production of drawn and rolled general purpose pipe and large diameter welded pipe for main oil and gas pipelines.

At the present time pipe up to 1,420 mm in diameter is being produced, the production of pipe for operating pressures is 7.5 MPa (75 atmospheres) for northern regions of the country has been mastered. Enterprises in the branch, producing large diameter pipe, in cooperation with the workers of the Central Scientific Research Institute for Ferrous Metallurgy,

VNITI Institute, the Institute of Electric Welding imeni Ye.O. Paton are working on further improvement of the quality and operational reliability of pipe. An increase has been made in the volume of non-destructive testing of welded joints, welding apparatus has been modernized and the quality of products improved.

The introduction of the recommendations of the school will help metallurgists more successfully to provide main gas pipeline production projects with high quality products.

For better interaction of economic and union organizations, the USSR Ministry of Ferrous Metallurgy and Central Committee of the Union of Metallurgical Workers have formed a coordination council for the development among labor teams at enterprises and organizations in the ferrous metallurgy industry of Socialist competition for timely and good quality filling of orders for the delivery of pipe and other metal products for the "Urengoy-Pomary-Uzhgorod" gas pipeline.

The coordination council has developed a sequence of presentations of materials and awarded the victors in the competition - teams and leading workers in production - union certificates and free vacations, has assisted teams in concluding agreements for competition, has monitored the fulfillment of Socialist obligations taken on by metallurgists to accelerate the delivery of pipe and other metal products for the gas pipeline.

The Presidium of the Central Committee of the Metallurgical Industry Workers Union in February of 1983 summed up the results of 1982, the All-Union Socialist Competition for timely, good quality fulfillment of assignments related to the construction of the "Urengoy-Pomary-Uzhgorod" gas pipeline. The victors were announced to be the workers at the Pervoural'sk new pipe and Khartsyzsk pipe plants. They were awarded union certificates and prizes. The teams of N.I. Smirnov (Chelyabinsk pipe rolling plant), V.G. Lyadov (Pervoural'sk new pipe plant), D.P. Astakhov (Taganrog metallurgical plant), V.D. Boyarchuk (Severskiy pipe plant), L.P. Timoshenko (Kharsyzsk pipe plant, I.V. Sagirov ("Azovstal'" plant), V.S. Krivobokov (Novolipetsk metallurgical plant) and the Department of VNITI Institute headed by P.N. Kalinushkin, for achievement of good production results and significant contributions to successful completion of important orders for the gas pipeline, were awarded free vacations. Continuing the competition on the principle of the "working relay race" the metallurgists have taken on increased Socialist obligations for 1983 for acceleration of the delivery of pipe and other metal products for the gas pipelines.

6508
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PROGRESS AT STARYY OSKOL DISCUSSED

Leningrad LENINGRADSKAYA PRAVDA in Russian 29 May 83 p 1

[Text by Yegeniy Strakhov]

[Text] The reserves of the Kursk magnetic anomaly (KMA) have been estimated as 40 billion tons of ore with a content of up to 69% iron. Specialists believe that the KMA can provide an annual output of more than 100 million tons of iron for a long time.

In the 1970s in the vicinity of the KMA, a territorial-production complex began to be created with its center in the old Russian city of Staryy Oskol near which an electrometallurgical combine is being constructed.

Since that time the population of the city has more than doubled, and now numbers about 140,000 souls, and by the beginning of the next century there will be over a half million people there.

The city and electrometallurgical combine are growing, mutually influencing each other. The chief engineer of the combine, Valentin Kurdryavtsev, says:

"We understand the full measure of our responsibility for the fate of our city. We are building not only housing, but also cultural institutions as well."

It is true that a great deal has been built at Staryy Oskol: 26 kindergartens and nurseries, 6 general education schools, 44 shops, 69 public catering enterprises, a home of culture, 1 movie theater , 2 polyclinics, 2 hotels and much more.

For many years the Kursk magnetic anomaly remained only a raw material base for domestic metallurgy. The ore mined here was sent to metallurgical plants in the industrial centers of the nation. With the start-up of the first section of the Oskol'skiy electrometallurgical combine it will be converted to a supplier of high quality steel, will become a center

of high quality metallurgy.

"The technology of the combine is progressive, it is of the future," continues Valentin Kurdryavtsev. "Electrometallurgy will yield metal of guaranteed high quality. We shall use the purest ore in our country. There is no danger of contaminating the metal with harmful elements. I believe that after finishing by our technology it will be used on the largest scale."

The first steel of the Oskol'skiy electrometallurgical combine should be produced in December of 1983, and after its full capacity is reached steel will be produced 7 times more than at all of the electrometallurgical steel plants now in operation in the entire nation. Steel will be produced here not from cast iron but from metallized pellets. This is the nation's first enterprise in which the metal will be produced by direct reduction of iron.

The advantages of the new process include its minimal effect on the environment, which is explained by the absence of the blast furnace process, by underground (through pipes) delivery of raw materials and fuel to the combine, as well as the closed water utilization system.

In mid-November of 1982, the first Oskol'skiy electrometallurgical combine enterprise was put on line - the plant which roasts and pelletizes the oxidized pellets. In one report from Staryy Oskol, Pravda called the building of the combine a model of how modern industrial giants costing several billions of rubles should be built, noting particularly the city had begun preparing for construction five years before work began at the construction site.

Training of personnel was also begun early at Staryy Oskol. In 1980 the Staryy Oskol professional and technical school of metallurgists graduated the first group of specialists for the combine. For five years in a row the enterprise has each year sent 60 to 70 persons to study at the Moscow Institute of Steel and Alloys. In Staryy Oskol itself there is an evening department of this institute, and a building is being constructed to open a day studies department. In the 1982/1983 school year some 10,000 mass profession specialists were trained in special technical schools, and 4,000 workers improved their qualifications. Twenty-five engineers from the combine underwent on-the-job training at a related enterprise in West Germany.

The face of the territorial production complex which is being carved out here is determined not only by the world's largest electrometallurgical combine. No less gigantic are the other enterprises under construction.

The raw materials base of the Oskol'skiy electrometallurgical combine is the Lebedinskiy mining and beneficiation combine, from which a 26-kilometer double slurry line of special high strength steel now stretches.

Through it slurry containing iron ore concentrate will be transported at a pressure of 80 to 100 atmospheres. Many people have worked here for decades. However, it would be an error to think that the builders are the only ones who live here. Staryy Oskol is becoming a true cultural center. The "Gorizont" studio combines some 30 young writers. In the city are 4 discotheques which, as the local young workers say, unfortunately can hold only 400 persons. There are dozens of young persons involved in the city jazz club. Almost 1,500 builders participate in artistic independent activities (35 in all). On the initiative of electric technician Gennadiy Kryukov, a speleological section was created - one at the Oskol'skiy electrometallurgical plant, another at the Stoylenskiy mining and beneficiation combine.

This list could be continued, but in Staryy Oskol they say that organization of benefits is still lagging behind the rapid growth of the city's population.

...In the morning thousands of Staryy Oskol residents hurry by high speed tram to the construction sites of the combine 25 kilometers from the city. Buses and large trucks follow the same path over a multiple lane highway. The trams hurry through the fields, flashing past stations with names unusual for this type of urban transportation system - "Vorotnikovo village", "Neznamovo village"...

The combine is under construction. Many high speed tracks, new mines, quarries, underground mines and enterprises are appearing on this rich land.

6508
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POTENTIAL FOR SAVING METAL

Moscow PLANOVOYE KHOZYAYSTVO in Russian No 5, May 83 pp 97-102

[Text by L. Zusman, Doctor of Economic Sciences, Professor]

[Text] Intensification of social production is closely related to conservation of materials, a trend in the development of metallurgy, machine building, the construction system and other branches which utilize machines and equipment, mechanisms and apparatus, the repair of which each year accounts for a fourth of the volume of all metal products produced.

The greatest effectiveness from saving of metals is to be found in moving objects (railroad cars, trucks, cranes, etc.) and increases in their reliability and durability. This is explained by the fact that the effect of weight reduction is reflected not only in reduced cost of the metal used to manufacture the object in question, but also the operating cost for its entire service life. This latter savings is generally dozens of times greater than the former, even considering the time factor. Increasing the reliability and durability of machines allows a decrease in the number of repairs and quantity of spare parts expended on removal of worn elements and installation of replacement elements, approximately 20 times the cost of one ton of rolled metal. Furthermore, there is an increase in the productivity of equipment due to reduced down time for repair; operating costs and capital investment for the creation of new facilities are reduced. In 1981 the savings of metal in metallurgy in comparison to 1970 was about 1.8 million tons. It was achieved mainly in rolling processes by expanding the use of continuous casting of steel on machines with the production of a rolling blank, by the assimilation of products with minus tolerances and output of products to consumers at theoretical weight, frequent replacement of "killed" steel with "semi-killed" steel, with less shrinkage crack depth and other progressive metal saving measures.

The quality has increased and assortment has expanded of rolled products. Thus, in 1971-1981 with a total increase in production of 27.8 percent, the output of rolled products with strengthening heat treatment has been increased by a factor of 1.9, the output of low alloy steel by a factor

of 2.1, of thin sheet cold rolled steel by a factor of 1.5. The manufacture of bent shapes during this period has increased by a factor of more than 4.

To satisfy the demands of the aviation, power engineering, electronic, nuclear, chemical machine building and instrument building industries for metal with particularly high and new properties, in recent years the production of alloy steels and alloys by new technological methods has been undertaken: electric slag, vacuum-arc, vacuum-induction, electron beam and plasma arc remelting.

In 1976-1980, some 968 new complex rolled shapes went into production, including 339 hot rolled products with a total volume of 4.6 million tons. The result was a savings of 246,700 tons of metal, the economic effect being about 39 million rubles. The manufacture of bent shapes increased to 1.47 million tons which, according to consumers, resulted in a savings of 244,000 tons of metal and other types of expenditures for a total savings of 35 million rubles. In 1980 the production of rolled products with minus tolerances was 42.7 million tons as opposed to 29.6 million tons in 1975. As a result some 800,000 tons of metal was saved.

The quality improved and assortment expanded of steel pipe; in 1973 for the first time, thermal hardening of this pipe was begun, resulting in a decrease in operational metal consumption; the output of high strength casing and drilling pipe with new types of threaded joints is developing rapidly. Since 1975 the production of 1,420 mm diameter gas pipe, which can increase throughput capacity and decrease metal consumption, has been undertaken.

In 1976 new All-Union state standards were introduced for ferrous metals, restricting the limits of deviation in dimensions of rolled shapes from the nominal and increasing the minimum level of strength indices. This has helped to improve the quality of the metal.

However, the total volume of production of finished products over the past years has not increased. In 1978 it was 105.4 million tons, in 1979 103.2, in 1980 102.9, in 1981 103 and in 1982 102 million tons.

The main reasons for this situation have been shortcomings in the preparation of the raw materials base and in the supply of coke; renewal of plant and equipment, the physical wear of which has increased over the past 15 years from 29 to 36 percent; and in major construction. There are also organizational and engineering factors within the branch which have prevented fulfillment of the plan for production of cast iron, steel and rolled products, including increases in the quality and assortment of metal products and economies.

As a result of the savings of metal by consumers in 1980 in comparison to 1975 (due to the use of metal products of better quality and improved assortment) the use of metals was less than planned. According to the USSR State Supply Commission, the assortment of rolled products delivered to consumers in many cases is not the same as that ordered, causing an additional consumption of 750 to 800,000 tons of metal per year.

Based on estimates of the USSR Central Statistical Administration, the savings in rolled ferrous metals in the main machine building branches, consuming about 80 percent of the total volume, was (in thousands of tons): in 1976 - 869, in 1977 - 1,028, in 1978 - 902, in 1979 - 798, in 1980 - 775 and in 1981 - 757. It is less than the relative savings established by the state planned for economic and social development of the USSR national economy for the Tenth Five Year Plan, and the planned mean annual level for the Eleventh Five Year Plan. The utilization factor of rolled products averages 0.72.

The quality and structure of products produced by machine building enterprises have improved, the design of many types of machines has been significantly changed, unit capacities have increased, the specific metal and power consumption have grown. In railroad car building, one of the most highly metal consuming sub-branches of heavy machine building, as a result of scientific research, design and experimental work performed over the last 10 years the mass of load-bearing structures of freight cars has been decreased by 20 to 25 percent, the corrosion resistance of individual units and parts has significantly improved. The use of new types of steel for walls and roofs of cars has allowed, by decreasing sheet thickness, a decrease in the consumption of rolled products by as much as 200 kg per car. This has helped to provide a great savings in scarce rolled products.

There has been a decrease in specific consumption of certain types of hoisting and transport and metallurgical equipment, diesels and diesel generators, trucks, tractors, excavators, etc. The calculated productivity of an EG-12 excavator built in 1980 at the Urals Machine Plant was 3,000 cubic meters of rock per shift, or 1,000 cubic meters greater than the series produced EKG-8, the bucket capacity was 12 cubic meters, 1.5 times greater, while the weight was 100 tons less. Hydraulic control of working organs is basically new, and is used at present only in highway excavators with low power capacity. The design of the All-Union Scientific Research Institute for Metal Machine Building for the synthesis of diamonds utilizes a system of lighter strip type uprights with great strength. As a result, a 2,000 ton press weighs 8 tons instead of 30 tons with the older design.

Significant reserves for savings of metal and labor can be found by increasing the technical and operational level of machines and equipment, such as hoisting and hauling, forging and pressing, construction and road working machinery for the light industries, food and other branches

of industry. Particularly pressing is the task of increasing the quality, reliability and durability of agricultural machines. The design of some of these machines is obsolete. Frequently the quality of assembly of machines is poor, requiring that consumers use their own efforts under poor conditions to bring them up to working conditions. As a result the time when agricultural equipment is intended to be ready for field work is not met, and the fact that this equipment is not available during planting or harvesting results in great losses to the harvest.

No less important is the solution of the problem of assuring reliability and durability of machines and equipment in other areas of the economy. In industry, for example, one hour of down time per day throughout the year due to poor quality leads to a decrease in the output of products costing some 40 to 50 billion rubles. To this we must add the additional cost of excess repair equipment.

In ferrous metallurgy the main tasks are preparation of optimal raw materials and fuels based on expected consumption of iron, coking coal and the creation of the corresponding mobile manganese ore, chromite and other types of raw materials for alloying steel; the replacement of open hearth production with oxygen converter production and electric steel making; the introduction of continuous casting of steel; the elimination of some rolling mills and process equipment, modernization and redesign of which would be ineffective; the redesign and modernization of rolling and pipe rolling mills in order to improve the quality of products manufactured on them and expand the assortment of products produced, including by broad utilization of savings in complex shaped profiles for general use and use within the branch in machine building and construction. The structure of rolling mills should be altered within the branch in the direction of increasing the fraction of thin sheet hot and cold rolling mills; the capacity for treatment of products outside the furnace, heat treatment and thermomechanical working of products, manufacture of rolled product with anticorrosion coatings, cold drawn steel strips, standard rolled products, cold bent and complex shaped profiles of high accuracy, high quality powder metallurgy products should be increased. A corresponding increase in the prospective demand for metal products (considering the potential possibility of its economic utilization) is required based on the redesign and increase in production facilities in ferrous metallurgy, particularly by elimination of the disproportion between individual cycles of metallurgical production at enterprises and original balances of production and consumption.

The implementation of these steps can achieve significant savings of metal in its manufacture and consumption. However, this will require great capital investment.

Table. Influence of Scientific and Technical Progress Factors on Savings of Ferrous Metal Rolled Products in Machine Building

Source of Savings	1970 as % of 1965	1975 as % of 1970	1980 as % of 1975	1985 planned as % of 1980
Use of improved quality rolled products of wider assortment	15.2	23.2	17.4	27.8-30.0
Use of rolled metal product replacements	6.4	7.6	5.8	7.8-10.0
Improvement of technological processes and increased utilization factor or rolled metal products	56.2	39.8	43.5	32.8-30.0
Improvement of design and weight characteristics of machines	22.2	29.4	33.3	31.6-30.0

Machine building and metal working have significant internal reserves for savings of metal. According to estimates by the scientific and technical commission GKNT, more than half of machines produced by the agricultural machinery ministry, and 40 percent of models of equipment produced by the Domestic Machinery Industry are inferior to the best domestic and foreign models in terms of productivity, metal consumption, reliability of key units, and conditions of labor of operators. The level of metal consumption of hoisting and hauling and storage equipment, tools and equipment, units, parts and blanks for general machine building use is high due to the dispersion of the production among many branches and enterprises. The task of forming specialized branches for the production of hoisting-hauling and storage equipment, general machine building products is being solved slowly. However, the creation of these devices would allow provision of the necessary concentration of production of similar products, improving the technical level including by decreasing metal consumption.

There are tremendous capacities for improving the quality and increasing the level of utilization of metal in effective introduction of the achievements of science and technology to production, the development of new and progressive technological processes, improvement of machine designs, etc.

The data presented in the table show that the significance of individual factors has changed over a 20-year period. In 1976-1980 the influence of improvement of quality and assortment of ferrous rolled metal products decreased. The decrease in savings of metal in comparison to the planned savings resulted from significant underfulfillment of the plan for production of low alloy high strength steel, heat treated rolled products, thin sheet steel, particularly the thinnest cold rolled steel, lightweight beams and channels, bent rolled profiles and other economical forms. The economy in connection with the use of substitutes for rolled ferrous metals was not fully realized due to a shortage of aluminum, heavy nonferrous metals and plastics to be used in machine building.

The situation is somewhat better in terms of the savings of rolled products due to machine building factors. It is important to note however that rolled products represent less than 60 percent of the total consumption of structural metals in machine building, the remaining portion being steel pipe, products of metallurgical processes, cast iron and steel castings, the consumption of which has not been standardized in a centralized manner. However, to avoid overconsuming rolled products they are frequently replaced with cast products, although this causes an increase in the weight of machines and equipment. As a result of ineffective replacement the ratio of the production of all cast iron castings to rolled products was reduced from 17.6 percent in 1970 to just 16.1 percent in 1981, while the corresponding figure for steel castings during this same period remained unchanged at 5.7 percent. Therefore as a whole the consumption of castings by all types of metal products in machine building decreased by only 1.5 percent. The increase in the fraction of the machine building factors in metal savings has resulted significantly from a decrease in the fraction of metallurgical factors, since the utilization factor of metal in machine building and metal working during this period remained at the 0.71-0.72 level.

According to the plan for 1981-1985 there is to be a significant increase in the specific share of metallurgical factors in comparison to 1976-1980 and a decrease in the influence of improvement of technological processes and the metal utilization factor. In machine building and metal working by 1985 a coefficient of 0.79 percent is to be achieved. This significant increase obviously will follow from the balance of production and consumption according to which, in accordance with the expanding output of rolled products in the Eleventh Five Year Plan by 18 percent, it is planned to increase the volume of machine building products (as expressed by cost) by 40 percent. Actually over the past two years of the Five Year

Plan the volume of output of finished products has remained at the level of 1980 and the production of machine building has increased slightly. However, this does not mean that in 1981-1982 a savings of metal was achieved in machine building of equal dimensions. This result reflects the change in the branch structure of machine building (where the consumption of metal products per million rubles of machine building products differs greatly), the structure of products with various levels of metal consumption, the structure of structural materials, the increase in standard prices per unit of comparable types of products and, finally, a change in the level of metal consumption in the products produced.

The relatively low level of utilization of metals in metal working and machine building has been built up under the influence of the structure of preparatory production in machine building where the total volume of metal working equipment consists of 84.5 percent of metal cutting machines, the remaining machines being forging and pressing equipment. This in turn results from the assortment of rolled products used, the great fraction of cast iron and steel castings and the shortage of stamped and welded metal structures.

At the present time the capability of sheet rolled production has been significantly improved in connection with the increase in the unit power of thin sheet rolling machines (to 6-8 millions tons of products per year) and the expansion in the production of cold rolled sheet steel down to 0.5 mm thick. The increase in the fraction of sheet steel in the total volume of rolled products, including cold rolled sheets in the total production of sheet rolled products, the decrease in the mean thickness of sheet steel, the expansion of its manufacture with metallic and non-metallic protective coatings are among the most important trends in the improvement of the structure of metal consumption and the achievement of significant metal savings.

Further increases in the effectiveness of the machine building industry will depend to a great extent on the quality of production of cast and forged-pressed products. Primary development in casting production is to be seen in the increase in the quality and accuracy of castings by introduction and expansion of the friction of progressive technological processes in the total output of castings by reducing the fraction of castings in sand and clay molds, creation of continuous flow and automatic production lines. Further concentration of casting production is important.

In 1980 the specific share of cast iron and steel castings manufactured by progressive methods in comparison to 1970 increased (in percent): with the use of quick setting mixtures - from 5.15 and 24.9 to 11 and 28; in chill molds - from 8.8 and 7.43 to 10.2 and 5.5; in investment models from 0.027 and 1.49 to 0.002 and 2.28; in envelope molds - from 0.55 and 0.82 to 1 and 1.2, total from 14.52 and 34.64 to 22.22 and 36.98. Although in 1971-1980 the specific share of progressive methods in casting production increased slightly, the predominant portion of casting was

manufactured by obsolete methods. Therefore, metal losses in processing remain relatively more than twice as high as possible levels which can be achieved by full introduction of progressive technologies.

In casting production we must accelerate the expansion of progressive processes based on modernization of cupolas or their replacement with electric furnaces. In the manufacture of synthetic cast iron castings in electric furnaces high quality is achieved by decreasing the content of sulfur and phosphorus and ideal mixing, making the materials homogeneous in chemical composition and temperature. This allows production of castings of good quality with any configuration, reducing rejects and metal loss to 1.5 percent (instead of 6 percent in cupolas).

The major technological reserve for improvement of the use of metal is the replacement of forged blanks of standard rolled products by cold stamped blanks from sheets. A significant savings in cold sheet stamping is achieved by effective cutting and selection of optimal sheet dimensions, the use of waste-free and low waste technology, the use of wastes formed in cutting. The experience of the motor vehicle industry has shown that the greatest economic effect is achieved by measures designed to improve cutting patterns. Particularly effective is combined cutting - the manufacture of parts of various shapes from a single sheet.

Increasing the level of metal use in forging and pressing has resulted in the introduction of such progressive technological processes as the manufacture of forgings and stampings on hot crank stamping presses, closed impression die forging, precision flashless stamping, extrusion and upsetting. As a result high accuracy of dimensions and volumes is achieved, and sometimes complete elimination of mechanical working.

Further development will be seen in the production of rotary forging machines for the manufacture of solid and hollow stepped shafts up to 100 mm in diameter by radial forging machines with programmed control, as well as forging hydraulic press manipulators, hydraulic forging presses, machines for hot closed impression forging. Broader use should be made of blades for precision cutting of quality rolled products; hot stamping presses with split dies, high speed hammers; multiposition automatic machines for hot upsetting of parts such as bearing rings, sleeves, and large nuts; hydraulic screw presses for the manufacture of large stamping; hydraulic multiple plunger presses for flashless stamping; two impact and multi-position automatic machines for the manufacture of bolts, nuts and screws; presses for finish cutting and vibration cleaning, as well as other progressive types of forging and pressing equipment. All of this will provide an increase in the quality of forged and pressed products, the productivity of labor and a significant savings in metal.

Forging and pressing production should be developed at higher rates in comparison with casting and metal cutting production, where the loss of metal with waste is significantly greater than when it is worked by pressure, and the quality of the products is lower. Of important signficance for increasing the technical and organizational level of manufacturing production is its concentration, in which it is economically expedient to use more productive casting equipment and progressive technological processes. The specific share of enterprises and shops manufacturing up to 1,000 tons of iron castings per year reduced from 50.7 percent in 1970 to 49.4 percent in 1980, while the output of the same volume of steel castings increased correspondingly from 61.2 to 62.7 percent. Obviously, there is inertia and unsatisfactory organization in the provision of enterprises where it would be desirable to eliminate obsolete casting shops. This same situation is seen in the forging and pressing and metal cutting industries.

An increase in concentration depends on centralized supply of enterprises with technological equipment and tools and the performance of major repair of machines and equipment by machine building enterprises. As long as equipment and tools are manufactured and capital repairs performed by enterprises (including small ones) independently, no significant changes in the concentration of casting and forging-pressing production can be expected.

The All-Union Scientific Research Institute for metal working machine building has developed a basically new and progressive, low waste technology for rolling of machine part blanks, which is already being introduced at some plants. For the first time in world practice, gear wheels, hollow shafts, axles, drilling rods and other parts are being manufactured by rolling. As a result the accuracy and durability of these parts has increased, the productivity of labor has increased several times.

However on the whole low waste technology is being introduced to machine building quite slowly. Only a fifth of all parts are manufactured by precision closed impression die forging, the method of open forging being used much more frequently. This leads to losses in metal and wastes up to one-third of the volume, and increases costs. The production of one ton of parts from open forgings costs 1,883 rubles, from standard rolled products by mechanical working on metal cutting machines - 1,386 rubles, by closed impression die forging - only 378 rubles.

There are many reasons for the slow introduction of low waste technologies. The most important is the low level of leadership of production, insufficient utilization of leading experience, the absence at enterprises of material interest in its introduction and unsatisfactory planning. The approved plans for production and the material-technical supply usually consider metal utilization factors based on the level achieved at the enterprise at the present time with a slight decrease. This conserves technologies which have grown in the past, and planned savings of rolled products

are achieved by partial replacement with cast products.

The experience of using progressive technologies in industry at some enterprises has been little utilized. For example, the Chelyabinsk tractor plant for 20 years has been rolling the teeth of gears instead of milling them. The same process is used at ZIL plant. Other plants in the agricultural machine building and motor vehicle industry ministries continue to work by the old methods, experiencing great labor and material losses. It is as if there were no such thing as leading experience!

Of important significance to change this situation is improvement in planning, cost formation and economic stimulus. The list of capital investments should, in our opinion, include first of all objects providing for the achievement of savings of metal by introduction of low waste technologies.

The reduction in the specific mass of ferrous metals in machines and equipment has resulted to a significant extent in their replacement by more economical types of structural materials. Among these are nonferrous metals which should be used for the manufacture of many parts of machines and mechanisms used under severe operating conditions, including in corrosive media; for surface coatings of sheet structures, apparatus and metal containers for food products and various chemicals.

The current level of development of the branch of machine building and instrument building demonstrates the need to use new polymer structural materials. The rapid growth in the production of structural plastics is a characteristic phenomenon for all technically developed nations of the world. In machine building most polymers are used for the manufacture of important parts and units in machines, mechanisms and instruments. One kg of these materials replaces as much as 4 to 5 kg of ferrous metal rolled products. The production of one ton of plastic products in comparison to the production of the same quantity of parts of metal requires, on the average, 540 manhours less and decreases the consumption of power by a factor of 2 to 3.

Some 25 to 27 percent of metal products are utilized in capital construction. In 1966-1970 the mean metal consumption of construction and installation work was 540 tons per million rubles, in 1971-1975 - 516, in 1976-1980 507, in 1980 - 480 tons per million rubles. However, the plan assignment for introduction of fixed capital is fulfilled to only 80-90 percent, production facilities - 40-60 percent. Therefore the actual metal consumption of fixed capital put into production is 11 to 25 percent higher than planned. However, the planned cost systematically increases not due to the dynamics of capital investments. In the Tenth Five Year Plan the mean annual rates of increase of summary planned cost of construction projects underway simultaneously was 6.9 percent.

Significant losses of metal are observed in the construction industry

due to inefficient utilization. In 1976-1979, the USSR construction bank tested its utilization in 80,000 construction projects and sites. It was found that in 10,000 of them the consumption of metal was not monitored, as established by the standards documents. The total volume of unnecessary utilization was 1.192 million tons of metal.

Institutes of the USSR State Construction Commission and ferrous metallurgy have analyzed plans for the construction of 432 pipe systems in 11 branches of industry. It has been found that almost every single system has been planned to use thick wall pipe. The weight of pipe in the agricultural ministry, motor vehicle ministry and nonferrous metal ministry of the USSR is one-third higher than necessary. The use of efficient structures for consumption of steel pipe while conserving the overall system size would allow a savings of about 370,000 tons of metal.

The problem of the transition to economical types of metal products is a complex one. It requires study and re-examination of standards, re-orientation of planners, designers and ordering institutions.

The main reserves for saving metal in construction are to be found in decreasing the mass of buildings and structures by more effective plan decisions and the use of lighter structural materials. The improvement of metal structures is directed toward decreasing their mass by utilization of steels of elevated strength, effective hot rolled and cold rolled shapes, the creation of technological structural forms convenient for continuous manufacture, the use of light weight partitions, roofs and walls. Decreasing the material and metal consumption of construction in many industrial buildings can be achieved by replacing bridge cranes with floor mounted hoists and hauling machines, reducing the mass of construction structures by 20 to 30 percent.

Up to the present time the problem of effectiveness of using metal structures in some types of industrial structures has remained debatable. Obviously, it is important to consider differences not only in the specific consumption of metal, but also in the total mass of materials used, in the duration of construction and operational costs for the maintenance of buildings and structures under various conditions of utilization. The utilization of public funds is a decisive indicator.

6508
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FLOTATION EXTRACTION OF URANIUM FROM SEA WATER

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA B: GEOLOGICHESKIYE, KHIMICHESKIYE I BIOLOGICHESKIYE NAUKI in Russian No 6, Jun 83 pp 3-5

[Article by A. A. Bezborodov, S. V. Lyashenko]

[Text] The extraction of many elements from sea water may become a reality in the very near future. One of the most needed and promising elements at present is uranium, whose reserves in ocean water are practically unlimited. The basic difficulty in extracting uranium is finding it in a dispersed condition in sea water.

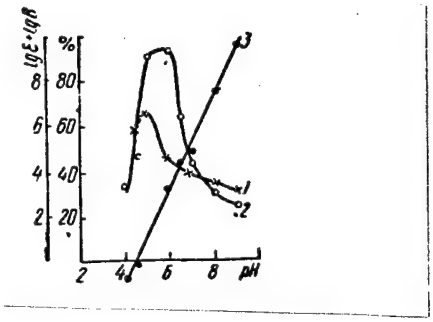
This paper is devoted to investigating the main possibility of extracting uranium from sea water by the foam flotation method and clarifying the mechanism of this process.

The method of doing this experiment was as follows. Nine liters of Black Sea water were poured into a flotation column, a 10-cm-diameter pipe made of polymethyl methacrylate glass. The uranium concentration in the water was 5 micrograms with a required pH value, regulated by HCl or NaOH solutions. Purified air was passed through porous glass filter No 4, installed at the bottom of the column. The foam (20 to 30 milliliters) was drawn off at a height of 5 cm above the level of the liquid. The uranium was analyzed by method [1] in the initial water, in the water after flotation, and in the foam which made it possible to determine the degree of extraction. "Stearoks-6" was used as the PAV [Surface Active Substance] in the form of a 10% water-alcohol solution (1:1).

Preliminary experiments established the maximum concentration of the PAV at 11 milligrams/liter and sufficient time for Bartizing the air at 15 minutes.

The maximum extraction of uranium is observed at pH 5 to 6 (see Fig.). Adding stearic acid as a collector increases carrying uranium into the foam. In acid and alkaline regions of pH values the degree of extraction is reduced which is related to the condition of the uranium and the PAV in sea water. "Stearoks-6" having surface-active properties and functional hydrophilic OH groups, is adsorbed in air bubbles and may appear as a cation-exchanger in the H^+ form. Uranium in sea water in the acid region of pH values is found to be in cation form [2]. An increase in its extraction up to pH 5-6 is due to

an increase in the cation-exchange function of the PAV. At a higher pH, uranium converts to negatively charged carbonate complexes and the extraction rate is reduced.



Uranium extraction from sea water by the foam flotation method:
1 -- "stearoks-6"; 2 -- "stearoks-6"+ stearic acid; 3 -- curve 1 data given in logarithmic coordinates.

We assume that during the flotation of the bubble a sorption equilibrium is established between the surface of the interface of the water-air (in the bubble) phases and the volume of the solution

$$RH^+ + M^{n+} \rightleftarrows RM + nH^+,$$

where R -- hydrocarbon PAV chain, secured to the air bubble; M -- adsorbed ion; n -- charge of ion.

Then the equation of the flotation extraction is derived like that which we obtained earlier in the case of ion absorption by hydroxides [3]. The quantity of cations that migrated to the surface of the bubble-water interface

$$RM = \frac{K[RH][M^{n+}]}{[H^+]^n}, \qquad (1)$$

where K is the exchange constant. Since salt concentration in sea water is constant we include the concurrent effect of the other cations in the process of sorption of the M^{n+} cation, in the exchange constant. The total cation concentration in sea water after equilibrium is established is determined as follows:

$$\Sigma C_M = M^{n+} + \Sigma ML_i + RM = M^{n+}\left(1 + \Sigma\beta_i L_i + \frac{K[RH]}{H^n}\right),$$

where L_i -- various complex-forming ligands; β_i -- stability constant of the ML_i complex.

The cation share that migrated to the surface of the interface, of its total concentration is

$$\alpha = \frac{K[RH]}{[H]^n B + K[RH]}, \qquad (2)$$

where

$$B = 1 + \Sigma\beta_i L_i.$$

We will represent equation (2) in form

$$\varepsilon = \frac{K[RH]}{[H]^n B}, \quad \text{where} \quad \varepsilon = \frac{\alpha}{1-\alpha} \quad \text{is the distribution coefficient}$$

Taking the logarithms of the last equation, we obtain:

$$\lg\varepsilon + \lg B = K + \lg[RH] + n\,\mathrm{pH}. \qquad (3)$$

Thus, if correct assumptions lie at the basis of deriving equation (3), the relationship between $\lg\varepsilon + \lg B$ and pH, at a constant quantity of PAV, must be a straight line, while the tg of the slope angle of the straight line is equal to the charge of the ion being floated.

In processing our data all possible forms of uranium in sea water which we previously determined [2, 4] were taken into account in factor "B." The conversion of data (see Fig. 1) into logarithmic coordinates actually gives a straight line relationship with tg of the slope angle ≈ 2 which confirms the assumption about the ion exchange mechanism of extracting uranium from sea water in the form of uranyl-UO_2^{2+} ion.

Uranium concentration in the foam under optimal conditions was 2.5 to 3 milligram/ liter, while at pH8 -- 0.7 milligrams/liter. When the uranium content in initial water is increased to 50 microgram/liter, the extraction rate practically does not change, while uranium concentration in the foam increases by an order of magnitude which, apparently, is not the limit.

The data cited indicate the possibility of the successful application of flotation for concentrating uranium from sea water.

Summary. Data of an experimental study on the possibility of the flotation extraction of uranium from sea water are presented. The method of foam flotation is shown to be effective for uranium concentration. An extraction mechanism is suggested, and an equation describing the flotation process fairly well is derived.

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2291
CSO: 1842/155

UDC 669.71:620.17:620.18

INFLUENCE OF MAGNESIUM AND IRON CONTENT ON STRUCTURE AND PROPERTIES

Moscow METALLOVEDENIYA I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 7, Jul 83 pp 52-54

KHOKHLATOVA, L. B., KOLOBNEV, N. I. and SETYUKOV, O. A.

[Abstract] A study is made of the influence of iron and magnesium content with maximum silicon concentration on a combination of properties of forgings in state T2. The structure and properties were studied on 60 x 120 x 270 mm forgings made from ingots 110 mm in diameter, homogenized at 490°C, 12 hours. Specimens were quenched in water from 500°C, holding time 90 minutes and then aged at 200°C, 12 hours. The degree of recrystallization of the solid aluminum solution, composition and volumetric fraction of excess phases were determined by quantitative metallography, x-ray structural and local x-ray spectral methods. The results of testing showed that AK8 alloy is not sensitive to corrosion cracking in the T2 state but sensitivity to delaminating corrosion increases with increasing iron content. The possibility is established of increasing fracture toughness by combined reduction of the content of magnesium and iron within the limits allowed by the type. However decreasing iron content decreases durability in low cycle fatigue testing. The change in fracture toughness and low cycle fatigue characteristics as a function of chemical composition results from changes in the volumetric fraction of zones impoverished in manganese and insoluble intermetallic phases. Figures 4; references 8: all Russian.
[157-6508]

UDC 669.71:620.13:620.17:621.785.78.784

CHANGE IN STRUCTURE AND PROPERTIES OF 1201 ALLOY UPON AGING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 7, Jul 83 pp 44-49

ARCHAKOVA, Z. N., KIRILLOVA, L. A. and SANDLER, V. S.

[Abstract] A slab 80 mm high, pressed profiles 15 to 30 mm thick and two types of forgings were studied to establish the change in structure and properties of 1201 alloy during aging. The studies were performed on the

standard specimens using standard methods. In addition to previously performed studies, the influence of artificial aging over a broader range of temperatures and times was studied. The maximum strength at 125-180°C is achieved in the stage of mixed aging, at 200-220°C - in the initial stage of full phase aging. Cold deformation of pressed and forged semifinished goods after hardening leads to an increase in strength properties in the hardened and artifically aged states. Deformation by compression after hardening results in equalization of properties through the height of forgings, a decrease in fracture toughness, some increase in heat resistance at 150°C and low cycle fatigue resistance. Cold deformation after hardening leads to acceleration of artificial aging and an increase in strength characteristics. [157-6508]

UDC 669.71'3:621.785.6.063:620.785.78.784

HARDENING OF SEMIFINISHED GOODS OF 1201 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7, Jul 83 pp 50-52

VERBOVOY, F. P., ZAYTSEVA, G. A., KONDRAT'YEVA, N. B., ANAN'IN, S. N., RYABIKHIN, I. P. and BOL'NYKH, A. T.

[Abstract] Forgings were hardened from 535°C (300 minutes) by quenching in water at 45°C, then artifically aged at 190°C, 18 hours. Based on analysis of the distribution of strength in the longitudinal direction considering distribution of cooling rates during hardening it is concluded that the change in strength depends directly on cooling rate. The results of the studies show that the maximum possible thickness of hardened semifinished goods should not exceed 150 mm, the depth of hardening of several other aluminum alloys. Figures 3; references 2: both Russian. [157-6508]

UDC 620.186.5:620.178.3

INFLUENCE OF GRAIN SIZE ON FRACTURE TOUGHNESS AND FATIGUE STRENGTH OF AK4-1ch ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7, Jul 83 pp 29-34

TELESHOV, V. V., SHTOVBA, Yu. K., SMOLENTSEV, V. I. and SIROTKINA, O. M.

[Abstract] AK4-1 alloy is widely used with recrystallization structure and various grain sizes. A study is made of the influence of grain size of pressed semifinished goods of AK4-1ch alloy on fracture toughness and fatigue toughness under various types of loading. Strips of 65 x 200 mm cross section were made of homogenized ingots 370 mm in diameter of an alloy

containing 2.1% Cu, 1.6% Mg, 1.1% Fe, 0.9% Ni, 0.17% Si and 0.05% Mn. Strips were pressed at 0.8 to 0.85 m/min, ingot temperature 470°C or 370°C (1 and 2). Container temperature was 400 and 350°C. The microstructure of templates in the hardened state showed that both strips had fine grain structure. Comparative studies of the material with various grain characteristics were performed. Aging kinetics were determined on the basis of short-term tensile strength and yield point. Endurance limit at 10^7 cycles, gage section diameter 10 mm with 0 extension was determined. Fatigue testing showed that σ_{-1} is greater in the transverse direction than in the longitudinal direction, endurance limit being virtually independent of grain size. The maximum strength properties were 10 to 20 MPa less for large grain specimens than for small grain specimens. Fracture toughness of specimens with large grain structure was greater than for small grain structure, apparently a result of the greater volume of plastically deformed zones in the large grain material. Figures 5; references 14: all Russian.
[157-6508]

UDC 620.18:620.17:669.71

INFLUENCE OF STRUCTURE AND PROPERTIES OF INGOTS ON QUALITY OF V95pch ALLOY SLABS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 7, Jul 83 pp 16-19

ZASYPKIN, V. A., LESHKOV, V. P., RUCHYEVA, N. V., SETYUKOV, O. A. and TSYPLUKHIN, I. P.

[Abstract] Aviation technology uses monolithic structures of large slabs, requiring slabs of up to 2 m in width. Ingots with a cross section of 400 x 2140 mm have been produced from V95pch and V95och alloys for the first time for this purpose. The alloys were melted in an induction furnace and an electric mixer and poured by a semicontinuous method at 40 to 45 mm/min, temperature of metal in mixer not over 700°C, in trough not over 672°C. The metal was refined on the path to the crystallizer by means of a titanium getter, a device with liquid flux and two glass screen layers with 0.6 and 0.4 mm apertures. The ingots were homogenized by heating to 465°C, holding 24 hours, cooling in air. The macrostructure of the ingots produced was fine grained, uniform through the cross section without crystal fans. The chemical composition of the Al_7(Cr, Mn, Fe) (Cu, Zn) particles by microscopic x-ray spectral analysis are presented. The temperature interval of crystallization of Al_7Cr particles in V95ph specimens was determined. Microstructural studies showed that the intermetallide particles which precipitate on the bottom of the ingot are formed only after isothermal holding at 645°C, 8 to 10° C above the liquidus temperature. The results presented of studies of the structure and mechanical properties of rolled slabs 2 m wide indicate that they can be used in new aircraft structures. Figures 7; references 4: 1 Russian, 3 Western.
[157-6508]

UDC 621.787(088.8)

INFLUENCE OF STRUCTURAL DISPERSION ON HEAT RESISTANCE OF DEFORMED STEELS AND ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 19, No 3, May-Jun 83 (manuscript received 26 Jul 82) pp 68-72

MAKSIMOVICH, G. G., YANCHISHIN, F. P., BARANETSKIY, V. S., KUDLAK, S. M., LOPUSHANSKIY, V. A. and SHCHEPANSKIY, Ya. S., Physico-Mechanical Institute imeni G. V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] A study is presented of the influence of dispersion of structure on short-term and long-term strength of deformed austenitic steels and alloys in the temperature interval from 20 to 75% of the melting point. It was experimentally established that with increasing grain size of the metal studied the characteristics of short-term strength at room temperature decrease, while the ductility increases. In contrast to the results obtained at room temperature, at high temperature the yield point and strength of initial and preloaded specimens with large grain structure are significantly greater than for those with small grain structure. The effects arising as a result of chemical interaction of dislocations with atoms dissolved in the matrix can be used in heat treatment to increase the heat resistance of steels and alloys. Steels and alloys with FCC lattice used at up to 0.4 Mp should be thermally and mechanically treated by TMO-1, helping to form a fine grain structure. If the same materials are to be used at higher temperatures, TMO-2 should be used, creating a stabilized large grain structure.
Figures 1; references 10: 6 Russian, 4 Western.
[156-6508]

UDC 669.112.227.346.2:669.788:620.186.1

INFLUENCE OF HYDROGEN ON DELAYED FRACTURE OF STEELS DURING WELDING

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 19, No 3, May-Jun 83 (manuscript received 7 May 81) pp 15-17

FEDOROV, V. G. and ALEKSEYEVA, L. Ye., Moscow Higher Technical School imeni N. E. Bauman

[Abstract] The hydrogen introduced during welding can obviously influence the kinetics of the $\gamma \rightarrow \alpha$ transition, decrease the temperature of martensite conversion and increase residual microstresses. This article studies the influence of hydrogen on the level of residual microstresses in the welded joint in steels with various contents of carbon and the tendency of these steels toward delayed fracture. Hydrogen was introduced directly during the process of welding, argon being used to protect the welding area from contact with air. The tendency toward delayed fracture was evaluated by a method described in a previous work. The stress required to cause fracture

in 24 hours was taken as an indication of delayed fracture tendency. Holding over 5 months in moist argon removes practically all the hydrogen from steels with 0.1 to 0.2% C, but significant quantities remain in steels containing over 0.2% carbon. Resting for over 5 months after welding eliminates the tendency toward delayed fracture only in the steels with 0.1-0.2% C.
Figure 1; references 6: all Russian.
[156-6508]

STUDY OF FRICTION AND WEAR RESISTANCE OF BILAYER TiN+Mo VACUUM-PLASMA COATINGS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 3, May-Jun 83 (manuscript received 15 Feb 82) pp 29-33

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[Abstract] A study is made of friction and wear resistance of vacuum-plasma coatings based on titanium nitride in a medium of aviation fuel in a friction couple with Khl2M steel heat treated to high hardness. The influence of an additional molybdenum layer applied by the same method on the TiN layer was also studied. In general the coefficients of friction for the coatings studied under the conditions of the experiments were most frequently 0.10-0.13, indicating that they are not antifriction coatings. Preliminary grinding of the TiN coating slightly decreases the coefficient of friction under low load conditions. For nonground coatings it decreases with an increase in load in the low load area, then becomes independent of load at 735-1960 N. Preliminary grinding has little effect on wear. Friction was unstable for all coatings studied, greater at the beginning of the test and decreasing with increasing test time. The relative wear resistance of the coatings was quite high, the variation of wear rate with load being impossible to determine under the test conditions. Figures 3; references 1 Russian.
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